A MANUAL

OF

# PHYSICAL GEOGRAPHY EXCURSIONS

GEOLOGY 4

BY

MARTIN, WILLIAMS, and BEAN

Pleistocene . .

. . . . . . . . . . . . . . . . . . . . . . . . .

Silurian . . . . tone.

· shale.

tone.

Ordovician lstone.

formity . . . . . .

Lower Magnesian limestone.

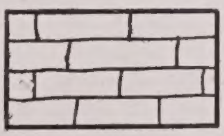
Cambrian . . . . . . . . . . . . . . . . . . . . . .Potsdam sandstone.

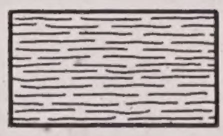
. . . . . . . . . . . . . . . . . . . . . . Unconformity . . . . . . . . . . . . . . . . . . . . .

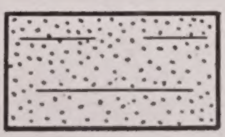
Pre-Cambrian . . . . . . . . . . . . . . . . . . .Baraboo quartzite.

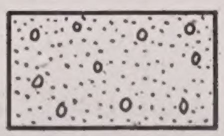


## SYMBOLS

 Limestone

 Shale

 Sandstone

 Glacial Drift

A MANUAL

OF

# Physical Geography Excursions

BY

LAWRENCE MARTIN
Associate Professor of Physiography and Geography

and

F. E. WILLIAMS and E. F. BEAN
Instructors in Geography

DEPARTMENT OF GEOLOGY
THE UNIVERSITY OF WISCONSIN

For use in the Field Work of
GEOLOGY 4 (PHYSIOGRAPHY)

Published by the University of Wisconsin
MADISON, WISCONSIN
1913

# CONTENTS

## LIST OF ILLUSTRATIONS.

# PREFACE

This manual of physical geography excursions is designed for use at the University of Wisconsin in the elementary elective course (Geology 4) in connection with the autumn and spring field work in the vicinity of Madison. The seventeen short excursions are intended for two and three-hour field trips in the neighborhood of the University, while the seven all-day excursions are to be taken on Saturdays.

The region around Madison lends itself to out-of-door study of physiographic processes and the forms produced by their operation. The country rock of the neighborhood is well-jointed sandstone, limestone, and shale of the Cambrian, Ordovician, and Silurian, lying in nearly-horizontal position and with abundant outcrops. Nearby to the north is the Baraboo Range, a syncline of pre-Cambrian quartzite. The variably-resistant Paleozoic rocks with slight southward dip were converted by pre-glacial weathering and stream erosion into the belted topography of a series of cuestas, in which the weak Potsdam sandstone belt had been reduced to a lowland in old age of the erosion cycle during the same time which had sufficed only to reduce the more resistant Lower Magnesian and Trenton-Galena limestones to cuesta ridges in a stage of late youth or early maturity. The glacial invasion left a drift mantle which partly masks this erosion topography, leaving striated rock ledges, transported bowlders of all sorts of sedimentary, igneous, and metamorphic rock, and youthful topographic forms of the ground moraine, drumlins, eskers, and recessional moraines. Nearby to the west, however, is the Driftless Area, with abundant illustrations of the exact type

of topography, drainage, and soil which formerly characterized the region around Madison, both in the areas underlain by the sedimentary rocks of the Paleozoic and the metamorphic rocks of the exhumed monadnock of the Baraboo Range. Lakes, with shoreline features and phenomena of filling, swamps, aimless stream courses, rapids, and extremely youthful post-glacial gorges (as at the Dalles of the Wisconsin, Excursion 20), are the result of the glacial invasion. The features of the glaciated region and the Driftless Area are utilized repeatedly in the excursions here outlined. No American college known to the authors has the advantage of so wide a range of easily accessible phenomena for the study of physiographic forms, especially in connection with Davis's method of structure, process, and stage.

The plan of this manual is to furnish a series of questions, based upon features studied at close range and examined in relation to the series of topographic and geological maps herein provided. These questions are so printed as to provide spaces for the answers, which are to be written out in the field, according to a method originated by the late Prof. R. S. Tarr, after they have been answered verbally in a discussion with the other members of the class and with the instructor. Later each student makes an independent written report which summarizes the results of the excursion. The study of a few typical rocks and minerals, of physiographic processes and topographic forms, and the use of contour maps is going on at the same time as the outdoor study, for each student has three two-hour laboratory periods per week throughout the year, two of them indoors and one in the field during the pleasant weather of autumn and spring. Necessarily, however, many topics are introduced in the out-door work before they have been touched upon in the lectures and textbook recitations or in the accompanying indoor laboratory work. No hesitancy is felt because this necessity arises, for in our experience the topics first presented in the field are much better appreciated and understood and more interest is taken in them when more

fully studied afterward in lecture and recitation. The spring field work is naturally more systematic and satisfactory and may be made more advanced on this account. Advantage is taken of the proximity of a region never glaciated by having the all-day trip to Blue Mounds in the Driftless Area (Excursion 18) on the first Saturday in the autumn semester, thus acquainting the student with the simple normal processes and forms of weathering and stream erosion before the more complex glacial features are studied in the short excursions near the University campus. A few illustrations of physiographic influences upon human affairs are introduced in connection with each excursion.

The excursions here presented have been taken by many generations of University of Wisconsin students. Some of the field trips were originated and utilized in years past by Professors R. D. Irving, C. R. Van Hise, W. H. Hobbs, J. M. Clements, C. K. Leith, N. M. Fenneman and others of the geological faculty of this University. The larger number of those included here were first worked out and written in the form now presented by the senior author, who has used most of them with students for seven years. The junior authors have added materially to the questions, which have been used in typewritten or mimeographed form for several years, so that each excursion represents what our experience has shown to be the most usable material for each of the trips outlined. Mr. Williams has done the major share of the work of putting the outlines in form for printing.

Geographical Laboratory, The University of Wisconsin.
Madison, Wisconsin, May 27, 1913.

# GENERAL INSTRUCTIONS

1. The time and the meeting place for each field trip is given at the head of the outline for that excursion.

2. Follow carefully any other special directions given at the head of the outline.

3. Every student must bring this manual of physical geography excursions and a good lead pencil on each field trip.

4. Excursion note books must be neatly kept, and will be examined in the field by the instructor from time to time to see that the notes are entered fully and carefully.

5. A report of each excursion must be handed in within *one week* from the date of the excursion. This report is to be made on $8\frac{1}{2}$ by 11 inch paper. Write on one side of paper only and follow all rules of English. The report should be a concise technical summary of the facts observed, usually covering only the subjects or topics listed at the end of the outline. Diagrams and cross sections asked for are to be made neatly, with sufficient explanations to make them perfectly clear.

Reports are to be placed in the proper slot in the bottom of the case in the hall on the third floor of Science Hall opposite Room 309. The reports will be corrected within a week of the time they are handed in and filed alphabetically in the compartments at the top of the case. Please reclaim these corrected reports regularly once a week during the field seasons of autumn and spring. Corrections should be noted

and studied carefully as they are on points which have a bearing on future work.

6. Credit in this field work is not given for mere attendance, but for actual observation during the excursion, as well as for accuracy in writing up the reports.

7. In order that the best work be done, it is necessary that the same order and attention be maintained in the field as in the laboratory.

8. No objection is made to the comparison of notes and discussion of observations by students, but each report must be the individual work of the student handing it in.

9. As a general rule none but members of the class are permitted to go on excursions. In exceptional cases, for good reasons, persons accompanied by class members, will be allowed to go with the class by arrangement with the instructor in charge.

10. In case of boat trips, the absence of some members of the class increases the average cost. Hence all are expected to go with the class unless they have an exceptionally good excuse presented in advance.

11. Excursions will not be postponed because of inclement weather until at the immediate time of starting. Do not decide this question for yourself, but report at the proper place unless in case of pouring rain. Whenever an excursion is postponed, the class will meet in the laboratory at the regular hour or as soon thereafter as is possible.

## EXCURSION 1

## UNIVERSITY CAMPUS AND ROOF OF UNIVERSITY HALL.

### Maps, the Use of Scale and Contours, Local Geography.

**Directions** Meet at the Geography Laboratory, Science Hall, promptly at the beginning of the laboratory period. In this exercise use is made of the Madison Quadrangle and Fig. 1.

**At Science Hall** Read the description on the back of the Madison Quadrangle. On the topographic map given you, how are the following designated? (Use diagrams in your answers where possible).

(a) Highways? ..........................................

..........................................

..........................................

(b) Railways? ..........................................

..........................................

(c) Streams? ..........................................

..........................................

(d) Lakes? ..........................................

..........................................

(e) Swamps? ..........................................

..........................................

(f) Buildings? ..........................................

..........................................

(g) Wooded Regions? ..........................................

..........................................................

Locate Science Hall on your map. Define its position and draw a rough, enlarged plan of the building as it appears on Fig. 1. ..................................................

..........................................................

..........................................................

What is the *scale* of the Madison Quadrangle? ............

Explain the meaning of this scale. .......................

..........................................................

..........................................................

..........................................................

..........................................................

What is meant by *relief?* ...............................

..........................................................

..........................................................

How is topography shown? ................................

..........................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is a *contour?* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How are contour lines colored on the map? . . . . . . . . . . . . . . . .

What is the *contour interval* on this map? . . . . . . . . . . . . . . . . .

**At Turn in Drive at West End of Stone Wall.** Orient the Madison Quadrangle. Determine your exact location on this map and on Fig. 1. What methods do you use in determining location? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How high are you above sea level? . . . . . . . . . . . . . . . . . . Above Lake Mendota? . . . . . . . . . . . . . . . . . . . . . . . Compare the following slopes, as to (1) steepness and (2) the arrangement of the contour lines: (a) the Upper Campus south of Engineering building. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

(b) the Lower Campus. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

(c) the bluff between you and the Hydraulic Laboratory, . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

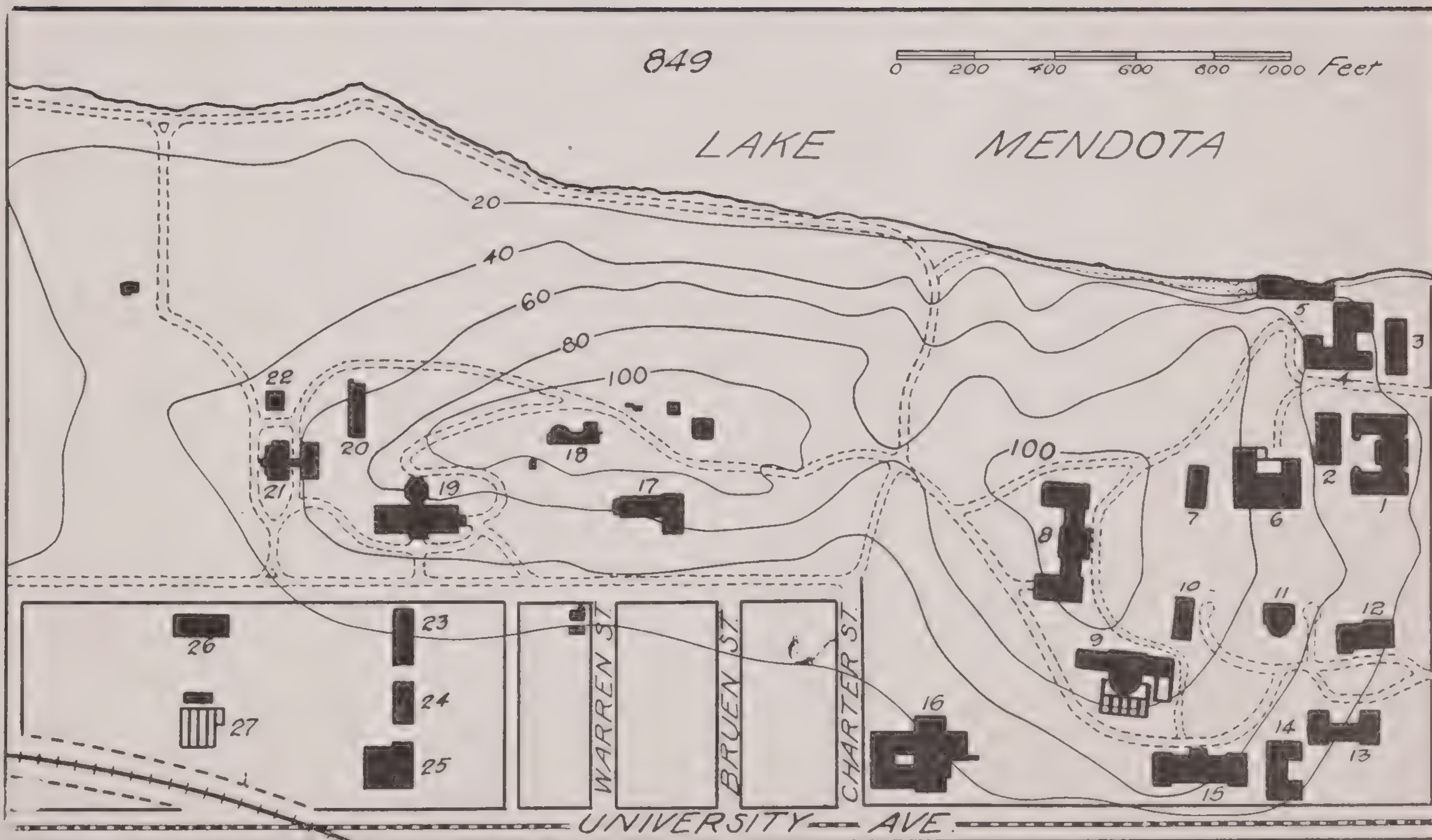



Fig. 1. Map of University of Wisconsin campus. Contour interval 20 feet; elevations measured from surface of Lake Mendota which is 849 feet above sea level.

Which of the above slopes does Maple Bluff most resemble?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Make a general statement regarding the arrangement of contours on (a) flats, (b) gentle slopes, (c) steep slopes. . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**At Mouth of Small Valley Along Shore Path.** What is the approximate compass direction to Maple Bluff? . . . . . . . .

To Picnic Point? . . . . . . . . . . . . . . . . . . . . . Why must the contours bend southward in this valley? . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Could they go straight across the valley? . . . . . . . . . . . . . . . . .

Downstream? . . . . . . . . . . . . . . . . . . . . . . . . . In following one contour, how much do you go up and down hill? . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . Make a general statement regarding the relation of contours to valleys . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Give the corollary for ridges. . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**Where Drive Reaches Lake Shore.** Exact location. What is the elevation above the lake? .................... As the drive extends westward does it cross any contours on the map? ....................................
Why? ................................................
........................................................
.......................... What is the elevation above sea level of the first contour line south of this drive? ...........
How far are you from Picnic Point? ....................

**Road Corner North of Residence of Dean of Agriculture.** Exact location. How far is it from the point where you joined the main drive to this road junction? ........
What is the ascent in feet from here to the Soil Physics Building? ................................................
Is this a uniform slope? ............................

**On Drive West of Hiram Smith Hall** Exact location. Are the slopes to the west and south of you gentle or steep? ..........
How are they shown on your map? ........
........................................................
........................................................
........................................................

**At Turn of Drive near Washburn Observatory** Exact location. How high is the Washburn Observatory above Lake Mendota? .............. What principles of contours in regard to ridges and slopes are illustrated here?....

..................................................................

..................................................................

..................................................................

..................................................................

**Crossing of Drives West of University Hall** Exact location. What is the elevation above Lake Mendota? .................... What is the distance from the lake?....... Slope in feet per mile? ........................ How obtained? ..................................................

..................................................................

..................................................................

..................................................................

..................................................................

**Roof of University Hall** Write the names of the University buildings numbered in Fig. 1.

**West Side.** In what direction and at what distance from University Hall (use Fig. 1) are:

(a) Chemistry Building? ..............................

(b) Home Economics Building? ..............................

(c) Washburn Observatory? ..............................

(d) Main Agricultural Building? ..............................

(e) Forest Products Laboratory? ..............................

(f) Camp Randall? ..............................

**Northeast Corner of Roof** How far and in what direction from University Hall are: (a) Biology Building? ..

..............................

(b) Science Hall? ..............................

(c) Engineering Building? ..............................

(d) Lathrop Hall? ..............................

(e) Chadbourne Hall? ..............................

(f) Music Hall? ..............................

(g) Library? ..............................

(h) Gymnasium? ..............................

(i) North Hall? ..............................

(j) South Hall? ........................................

Describe the system of street orientation (a) in the part of Madison near the university. ..............................

........................................................

(b) around the capitol square. ..............................

........................................................

........................................................

How far and in what direction from University Hall are:

(a) State Capitol? ........................................

(b) Camp Randall? ........................................

(c) State Hospital for the Insane? ........................

(d) Dane County Court House? ...........................

(e) Lake Wingra? ........................................

(f) Eagle Heights? ........................................

(g) Mendota Heights? ....................................

(h) Maple Bluff? ........................................

(i) Fair Grounds? ........................................

(j) State Fish Hatchery? ..................................

(k) Chicago and Northwestern Depot? ......................

(l) Chicago, Milwaukee and St. Paul (West Madison) Depot?

........................................................

(m) Illinois Central Depot? ..............................

In what direction is the Chicago and Northwestern Depot from the Chicago, Milwaukee and St. Paul Depot? ................

How is Madison situated with reference to Lake Mendota?

..............................................................

..............................................................

..............................................................

Lake Monona? ..................................................

..............................................................

Lake Wingra? ..................................................

..............................................................

What is the largest stream flowing into Lake Mendota? ......

..............................................................

From what direction? ..........................................

What direction does the Yahara River flow between Lake Monona and Lake Mendota? ..............................

How does the map show this? ...............................

..............................................................

..............................................................

Through what streams does the water from this area reach the sea? ..........................................................

..............................................................

..............................................................

Fig. 2 is a north-south cross section of University Hill near the Observatory showing the present topography, a well which reaches Potsdam sandstone at a depth of 113 feet, and the probable preglacial topography (dotted line). Complete Fig. 2, showing the sandstone and glacial till by appropriate symbols (inside of front cover).

**Note**: Draw a light line on Fig. 1, (to be inked-in later) to represent the route taken in the above excursion.

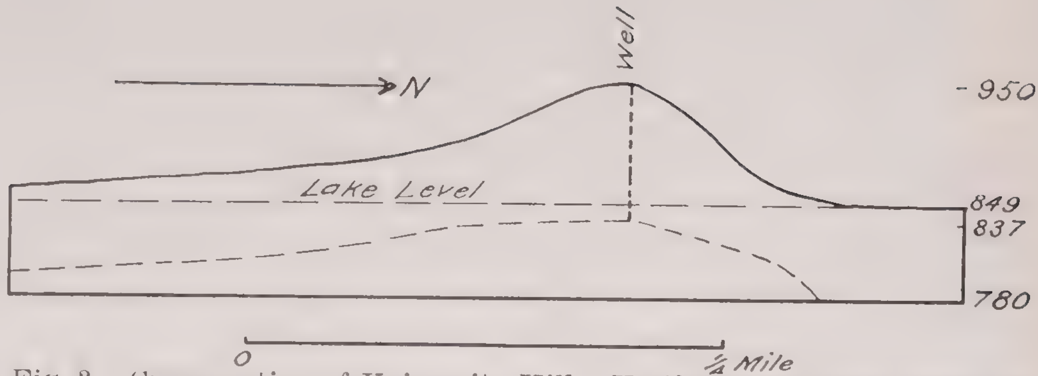



Fig. 2. Cross section of University Hill. Vertical scale three times the horizontal.

**Report.** Your report should consist of a concise description of the symbols used on a topographic map and their interpretation. Place special emphasis on the interpretation of contour lines, using specific illustrations.

EXCURSION 2

# CITY STONE QUARRY

## Materials of the Earth's Crust and Their Arrangement

**Directions** The class will meet at the corner of Park and State Streets near the Administration Building, taking the first west-bound Wingra Park car after 8 a. m. or 1:30 p. m. The total expense is ten cents for street car fare. In this exercise use is made of Fig. 3 of this manual. The instructor in charge of the class will provide geological hammers for use at the quarry.

**On the Car** Trace the route on Fig. 3 from the corner of University Avenue and Breeze Terrace to the quarry. Locate the quarry on Fig. 3. What is its height above sea level? ........

............................................................

............................. Above Lake Mendota (Fig. 3)? ............................ Distance from end of car line? ..............................................

**Cut in Surface Material Above Quarry** Does the upper material grade down into the solid rock below? ............ Is there a sharp contact? ........................

What is an unconformity? ..............................

............................................................

............................ Is this one? ..............

What other kind of unconformity is there? ................

..................................................................

..................................................................

Is the material consolidated? ..................................

Describe its general appearance. ...............................

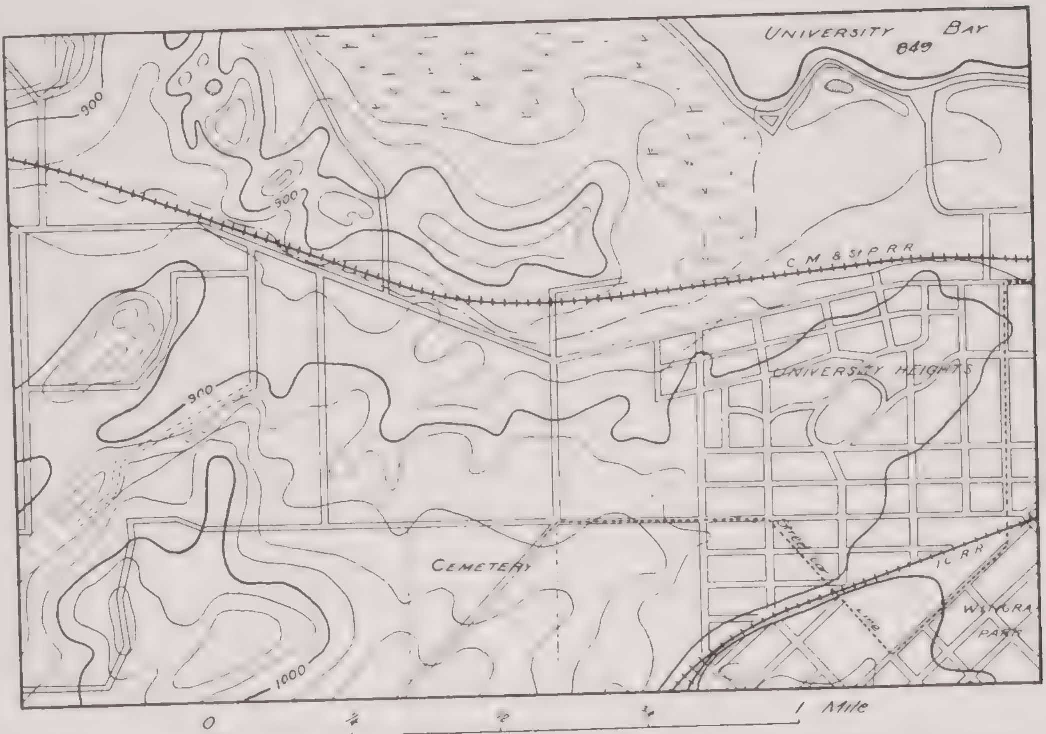



Fig. 3. Map of region near City stone quarry (after U. S. Geol. Survey). Contour interval 20 feet.

..................................................................

..................................................................

..................................................................

Are the constituent stones all of the same kind or do they vary?

.................................. Are they rounded, angular, or sub-angular? ..................................

Are the stones smooth, or scratched and striated? ...........

...............................................................

...............................................................

Are there *sedimentary* rocks here? ..........................

..........*Igneous?* ............................................

*Metamorphic?* ..............................................

List, in the following table, the rocks found here.

| Sedimentary | Igneous | Metamorphic |
|---|---|---|
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |

Of what is the finer material in the cut composed?..........

...............................................................

Is this material probably derived from original decay of the solid rock beneath? ............................

Reasons for your answer? ..........................

...............................................................

...............................................................

...............................................................

If it were such a residue what might this material be called?

...............................................................

Is the surface material transported? ......................

Reasons for your answer? ..........................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Name and discuss possible agencies of transportation. . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is the surface material unconsolidated or cemented? . . . . . . . . . . . . . . . . . . . . . . Is the solid rock, beneath the unconsolidated surface material, scratched and striated? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . What is the approximate compass direction of the *striae?* . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is the rock grooved? . . . . . . . . . . . . . . . . . . . . . . What relation have the grooves and striae to the constituents of the material above? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What part have the grooves and striae in the consideration and elimination of some of the possible agencies of transporta-

tion mentioned above? ........................................

..............................................................

..............................................................

..............................................................

Did the transporting agency move from a northerly or southerly direction? ........................ Reason? ..........

..............................................................

..............................................................

What was this agency? ........................................

..............................................................

**Upper Part of Quarry** Is the flat bench striated or grooved as above? ........................ Discuss the probability that this bench is a joint plane. ....................

..............................................................

..............................................................

..............................................................

A fault plane. ................................................

..............................................................

..............................................................

A bedding plane ..............................................

..............................................................

..............................................................

Do these rocks dip? ............................ Strike? .................. Describe their position. ................

..........................................................

..........................................................

..........................................................

Has their position been essentially modified since deposition?

.................................. Reasons for answer. ....

..........................................................

..........................................................

..........................................................

What kind of rock makes up the quarry face? ..............

How determined? ..........................................

..........................................................

Is there oolite present? .................................

Describe it. .............................................

..........................................................

Is flint or chert present? ...............................

Is it in bands or lenses? ................................

..........................................................

..........................................................

Are there shale bands? ...................................

Continuous or in lenses? .................................

Why? .....................................................

..........................................................

..........................................................

What is the effect of these variations on our knowledge of conditions of deposition? ..................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Are there *joints?* . . . . . . . . . . . . . . . . . . . . Vertical, horizontal, or inclined? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Is there more than one system of joints? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . What is the effect of joints on disintegration of rock? . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is the relation of joints to ore deposits? . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

To springs? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Do rock layers near the top of the quarry vary from those deeper down? . . . . . . . . . . . . . . . . . . . . . . . In what way? . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**Lower Part of Quarry** What kind of rock is present? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . How determined? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What are the constituent minerals? ........................

..................................................................

Discuss the hardness of this rock. ........................

..................................................................

..................................................................

..................................................................

Its solubility. ..................................................

..................................................................

..................................................................

Compare it with the rock above. ..........................

..................................................................

..................................................................

..................................................................

What do the presence of sandy limestones and limy sandstones tell about varying conditions of deposition? ..................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

Are joints well developed? ...................................

Where is the contact of the two kinds of rock? ..............

..................................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . How thick is the exposed part of the rock below the contact? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Of that above? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is this probably the entire thickness of either? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Why? . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Similar limestone and sandstone are found at Mendota Heights (northwestern corner of Fig. 3). What formerly occupied the valley space between this hill and Mendota Heights? . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What has become of the material? . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is the upper rock good for? . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

The lower? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

................................................................

................................................................

What University buildings are constructed of either? ........

................................................................

................................................................

................................................................

................................................................

Draw a northeast-southwest topographic and geological cross section of this quarry, letting 1 inch equal 30 feet in vertical dimensions and 1 inch equal 60 feet in horizontal dimensions. Use the symbols shown on inside of front cover.

Underline in the following list the rocks seen today:

- Pleistocene or Quaternary
  - Glacial drift.
- Ordovician
  - St. Peter sandstone.
  - Lower Magnesian limestone.
- Cambrian
  - Madison sandstone.
  - Mendota limestone.
  - Potsdam sandstone.

Trace the day's route on Fig. 3. How far in an air line are you from Science Hall?

**Report** Give a brief, clear account of the features observed on this excursion, following the topical outline. Where possible, combine the answers to related questions in one sentence.

EXCURSION 3

## CUT ON ILLINOIS CENTRAL RAILWAY

### Weathering and the Formation of Soil.

**Directions** The class will meet at the Administration Building, corner of Park and State Streets, taking the first west-bound Wingra Park car after 8 a. m. or 1:30 p. m. Bring ten cents for car fare.

**At Rock Outcrop on South Side of Railway** What kind of rock forms this outcrop? .............................. How determined? ..........................

..........................................................

...................... To which great class does it belong?

........................ Are any minerals noticeable in this rock? ..................... What mineral is probably most abundant? ........................... If minerals expand and contract at different rates, how would a rock be affected by alternate heating and cooling? ..................

..........................................................

..........................................................

Would the effect be greater on the outside of the rocks or within? ................... Why? ......................

..........................................................

..........................................................

Are there large cracks or joints in the rocks? ...............

Were these probably caused by alternate heating and cooling, or some other force? ...............................

Give reasons for your answer. ........................

..................................................

..................................................

..................................................

..................................................

..................................................

Could water enter these cracks readily? ....................

Does water expand or contract when it freezes? ............

........... Explain the effect of the freezing of water in the cracks? .........................................

..................................................

..................................................

..................................................

Are there any smaller, invisible cracks in the rocks? .........

.............. If so, would freezing water have the same relative effect as it does in the larger cracks? ...............

.................... Are there any small plants on the face of the rock? .................................. Describe them. ..........................................

..................................................

..................................................

Would the small cracks be of advantage to these small plants?

........................ How? ......................

..................................................................

..................................................................

As these plants grow, what will be the effect on the rock?

..................................................................

..................................................................

..................................................................

Are there any larger plants growing on these rocks? ........

............ If they send roots down into the larger cracks

what will be the effect on the rocks? ......................

..................................................................

..................................................................

..................................................................

Ground water contains certain acids and gases which greatly increase its solvent power. What effect would joint cracks

have on the movement of ground water? ..................

..................................................................

..................................................................

..................................................................

Where, then, would solution be greatest? ..................

..................................................................

..................................................................

How does solution increase the disintegration of rocks? ......

..................................................................

..................................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What becomes of the dissolved material? . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What are mineral springs? . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Where did the dissolved material come from? . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is "hard" water? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is there probably any dissolved mineral load in the water of the lakes at Madison? . . . . . . . . . . . . . . . . . . . . . . . . . . . . If the rocks in the drainage basin of the Madison lakes are largely the same as those in this outcrop, what is the nature of most of the dissolved material? . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What would the finding of numerous shells on the lake bottoms

tell as to the amount and kind of material in solution? ........

...............................................................

...............................................................

...............................................................

...............................................................

...............................................................

**At Cut in Till on the North Side of Railway** Examine several bowlders. Break off small pieces from each. Is there any difference between the outer surface and the fresh inner surface? ...................... Explain. .......

...............................................................

...............................................................

...............................................................

...............................................................

Are any of the rocks colored on the outside? ................

What colors? ..................................................

...............................................................

...............................................................

Do any have rust on the outside? ..................... What caused it? ...............................................

...............................................................

...............................................................

...............................................................

...............................................................

Some minerals decay faster than others. Explain how this

must affect the strength of the rock. ........................

............................................................

............................................................

............................................................

............................................................

............................................................

List all the agencies of weathering that you know. Check those seen here. ................................................

............................................................

............................................................

............................................................

............................................................

What becomes of the fragments broken off from rocks?

............................................................

............................................................

............................................................

Briefly state what may become of the different parts of rocks that are attacked by the agencies of rock weathering. ........

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

........................................................................

What is *residual soil?* ..................................................

........................................................................

........................................................................

........................................................................

How does the slope affect the thickness of the soil? ...........

........................................................................

........................................................................

........................................................................

........................................................................

What effect do plant roots and earthworms have on the texture of the soil? ........................................................

........................................................................

........................................................................

........................................................................

........................................................................

........................................................................

........................................................................

........................................................................

........................................................................

Would different kinds of rock produce different soils? ....... .............. Explain. ..................................

........................................................................

........................................................................

........................................................................

What relation would residual soil have to the bed rock?

Is this residual soil?

Describe this soil.

By what agency was it deposited?

Reasons?

Is it as good as or better than residual soil?

Explain.

...............................................................

...............................................................

...............................................................

...............................................................

Examine the black, top layer of soil where there is sod. Account for the color. ..............................

...............................................................

...............................................................

............................ Why is it rich?................

...............................................................

...............................................................

Why is forest mould so rich? ...........................

...............................................................

...............................................................

............................................... Why is swampy soil usually black? ........................

...............................................................

...............................................................

...............................................................

Sandy soil will do for potatoes, and clay soil is well suited to grass and grains. Why? (Consider the water-holding qualities of each.) ..................................

...............................................................

...............................................................

...............................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Upon what does the productivity of soil depend (consider composition and physical condition)? . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is meant by worn-out soil? . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How may it be replenished? . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Why is rotation of crops practiced? . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How does plowing clover under enrich the soil? . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

..............................................................

..............................................................

..............................................................

..............................................................

Trace the day's route on Fig. 3.

**Report** Summarize the points brought out on this trip in a concise, but not too brief, report. Follow the general outline of the exercise and combine answers to related questions in one sentence where possible.

## Excursion 4

## BETWEEN LAKES MONONA AND WINGRA

### Erosion, Transportation, and Deposition by Running Water

**Directions** The class will meet at the Administration Building, corner of Park and State Streets, taking the first South Madison car after 8 a. m. or 1:30 p. m. The total expense is ten cents for car fare.

**On Gravel Flat** This gravel flat (Fig. 4) was artificially leveled a few years ago, in connection with the excavation of gravel.

How has the flat been modified subsequently by nature? .....

.............................................................

.............................................................

Is this process at work in winter as well as summer? .......

In dry weather as well as during showers? .................

When rain falls upon this surface what should you estimate to be the proportions of evaporation (or drying up) percolation (or soaking in), and run-off? ......................

.............................................................

Which of these three processes is aided most by the nature of the material of the flat? ...............................

Why? ........................................................

Which by the topography? ............. Why? ..........

.............................................................

Does vegetation, such as grass and weeds, help or hinder the running water? ..............................

**West Edge of Gravel Flat Near Lake Wingra**

What has modified the western edge of the gravel flat since it was originally leveled by man? ..............................

How has the appearance or outline of this western edge been changed? ..............................................

..................................................

Does run-off or percolation take up more of the rainfall on this slope? .............Why?..........................

..................................................

What has excavated the little gashes in the edge of the gravels? ................... How can you prove this? ............

..................................................

..................................................

Were the streams of the permanent or the intermittent type?

..................................................

Choose one of the following names as most appropriate for these gashes, giving reasons for your choice:—valley, canyon, gorge, trench, rill channel, gully. ........................

..................................................

..................................................

By comparing several of them, prove: (a) that they are being lengthened by headward erosion, .........................

..................................................

........................(b) that they are being widened

by sliding down of the sides, ..........................

..........................................................

..........................................................

(c) that they are being deepened by steam erosion. ..........

..........................................................

..........................................................

..........................................................

The instructor and several students will determine the approximate slope of one or more of these gullies by use of the Locke hand level, while other students measure its length somewhat closely by pacing, afterwards checking this distance by the use of a tape. Fill in the following table:

Length of gully; .................... feet.

Descent of gully; .................... feet.

Average slope; at the rate of ................feet to the mile, or about ................ degrees.

Is the greater part of the descent at the head of the gully or near its mouth? ......................................

..........................................................

State whether the slope of the stream course is concave or convex upward. ......................................

At what rate do you suppose the water flows through these gullies? ..............................................

..........................................................

A stream current flowing 2 miles an hour will drag pebbles as large as a hen's egg; at $1\frac{1}{3}$ miles an hour it can just barely roll

pebbles an inch in diameter; at $\frac{1}{2}$ mile an hour gravel stones as large as peas are moved and sand is carried in suspension; at $\frac{3}{10}$ of a mile an hour fine sand is transported; but a current of $\frac{1}{4}$ to $\frac{1}{6}$ of a mile an hour will carry only clay. Deduce from the size of materials in the deposit before you, the limits of speed of the current when water flows here. From.... ......to .......... miles an hour. Discuss further..........

..........................................................

Examine the pebbles lying in the bottom of the gully. (a) Which ones (give diameter) were transported by the running water? ..........................................

..........................................................

(b) Which ones have rolled down to their present position through undermining of the sides of the gully?................

..........................................................

Are these pebbles angular or rounded? ....................

Would their shapes change if they were carried a greater distance by running water? Explain. ........................

..........................................................

**Deposit at edge of Swamp**

The stones in the deposit outside the mouth of the gully vary in size. Have all of them been transported by running water? ........Explain.

..........................................................

..........................................................

Considering fine sand and clay as well as pebbles, which ones could be moved in suspension? ...........................

Which ones only by rolling and dragging? ................

Is there any assortment in the deposit, showing relative sizes of fragments in relation to distance from the mouth of the gully?

What is the form of the deposit outside the mouth of the gully?

Why are the two words, *alluvial fan*, appropriate in describing it?

Measure this deposit, with the tape, and its slope, with the level, and write out a brief, concise description of it, accompanied by a rough sketch map (with scale) of the gully and the fan

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

The slope of the fan in feet per mile, is .............. The form of its slope (upward) is .......... Compare with stream course in gully. ....................................

............................................................

Has it abandoned channels on the surface? .........Describe them. ...............................................

............................................................

Were these streams cutting down (eroding, degrading) or building up (depositing, aggrading)? .....................

Did these stream courses shift in position? .................

Evidences of this? ..........................................

............................................................

............................................................

Explain why the alluvial fan was so evenly built, with subequal slopes in all directions from the gully to the swamp.......

..........................................................

..........................................................

..........................................................

Do any of the fans coalesce? ............What name might be used for such a slope, made up of coalescing alluvial fans?....

..........................................................

Is the swamp vegetation being buried beneath the stream deposit? ..........................................................

..........................................................

What economic resource, much used by man in cool temperate climates, is made by the solidification of buried, compressed, and consolidated swamp deposits? ..............................

**The Report** Write a brief, concise, one-page summary of erosion, transportation, and deposition by running water, proving your statements by specific illustrations from this excursion.

EXCURSION 5

## SOUTH MADISON AND LAKE WINGRA

### Marl, Peat, and Glacial Deposits

**Directions** The class will meet at the Administration Building, corner of Park and State Streets, taking the first west-bound South Madison car after 8 a. m. or 1:30 p. m. The total expense is ten cents for car fare.

**At the Gravel Bank** Locate yourself exactly on the map (Fig. 4). How far are you from Lake Monona? .................... From Lake Wingra? .................. How high are you above sea level? .................. How much higher is the top of the hill southeast of you? .............. What are the materials in the gravel bank? ........................

...........................................................

Are they stratified? ..............Which way do they dip? ........................Indicate this on your map by an arrow. Are there variations in the angle of dip?............. ..............What is cross-bedding? .......................

...........................................................

...........................................................

...........................................................

How does it differ from an unconformity? .................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .


Fig. 4. Map of region near Lakes Wingra and Monona (after U. S. Geol. Survey. Contour interval 20 feet.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Are the stones in this gravel bank rounded or angular? . . . . . . . .

..................Smooth or striated? ....................

Of one kind or of many? ..................... Which kind predominates (Count stones of one kind in several groups)?....

.................... Why? ..........................

.........................Are the stones cemented together or incoherent?..........................................

Can you call uncemented gravel and sand a rock? ...........

Name three common cements..................................

**Origin of this Deposit** Discuss the probabilities of this deposit having been:

(a) Wind-blown; ..................................

..................................................

..................................................

(b) River-transported; ..........................

..................................................

..................................................

..................................................

(c) Glacier-laid; ..................................

..................................................

..................................................

..................................................

(d) Wave-built; ....................................

..................................................

..................................................

..................................................

(e) Made by disintegration of older rock in place; ..........

..........................................................

..........................................................

..........................................................

..........................................................

(f) Made by combination of several of the above agencies. ...

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

Why may the name stratified drift be applied to this deposit?..

..........................................................

..........................................................

..........................................................

..........................................................

What is the relation of this material to the soil above?........

..........................................................

..........................................................

Of what use is this deposit? ..........................

..........................................................

..........................................................

List the rocks found here according to the following table.

| Sedimentary | Igneous | Metamorphic |
|---|---|---|
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| .................... | .................... | .................... |

**Along Drive in Swamp** Be sure and follow exact location on your map. Examine the whitish material along the drive. Tell why it may or may not be: (a) till; ............

..........................................................

..........................................................

(b) lake clay; ..............................................

..........................................................

..........................................................

..........................................................

(c) stratified drift; ........................................

..........................................................

..........................................................

..........................................................

What name is applied to the whitish material?..............

What is the origin of the shells in it?.......................

..........................................................

..........................................................

Can shells be found in the canal along the drive? ...............

What is the fine dark material that is mixed with the broken shells? ...................................................

.......................................................

Is this a rock? ...............................................

.......................................................

What is bog limestone? ....................................

.......................................................

.......................................................

.......................................................

Uses? .............................................

.......................................................

Are rocks ever organic? ....................................

What name may be applied to the dark surface material in the swamp? ......................Is it still forming? .......... ................Evidences? ..........................

.......................................................

.......................................................

How are plants helping in more than one way to fill Lake Wingra? ..............................................

.......................................................

Have they encroached over a relatively large or small portion of the former lake area (Fig. 4)? ...........What may the deposit formed by plants become? ..........................

Are swamp deposits advantageous or detrimental to man? .....

..............................................................

..............................................................

..............................................................

..............................................................

**Glacial Cut near Vilas Park**

Is this deposit stratified? ....................

Are any of the small stones scratched?..........

........... Are any of the rocks decayed? .....

Examine the scratches on the large bowlder or ledge. Discuss the following as probable agents for producing these scratches

(a) Streams; ..............................................

..............................................................

..............................................................

(b) Waves; ..............................................

..............................................................

..............................................................

(c) Wind; ..............................................

..............................................................

..............................................................

(d) Glaciers; ..............................................

..............................................................

..............................................................

(e) Man; ..............................................

..............................................................

..............................................................

What effect may the small stones have had on the large ones and

on the ledges? ............................................................

.......................................................................

.......................................................................

What is the direction of the scratches or striae? ..................

......................... Is the large rock *in place*, i. e., part

of a ledge? ............................................................

Would it be necessary to know whether the rock was in place in

determining the direction of ice movement? ........... Explain.

.......................................................................

.......................................................................

.......................................................................

What would be the effect of stream-rolling on scratched

bowlders? ..............................................................

.......................................................................

.......................................................................

......................... Were those in the gravel bank probably

ever scratched? .......................................................

.......................................................................

Is the clay due to decay? ..........................................

.......................................................................

.......................................................................

Is it a lake deposit? ..................................................

.......................................................................

.......................................................................

Is it the unassorted product of crushing and grinding? ........

.................................................................

...................................Why may it be called

bowlder clay? ...................................................

.................................................................

What is the relation of the till, or bowlder clay, to the soil

above? ..........................................................

.................................................................

.................................................................

.................................................................

Write down the differences and similarities of material here and at the gravel pit in the following table.

| Materials and Conditions. | Gravel Pit. | Vilas Park Cut. |
|---|---|---|
| Stratification ...... | .................... | .................... |
| Materials present .. | .................... | .................... |
| Shape of stones .... | .................... | .................... |
| Size of pebbles ..... | .................... | .................... |
| Scratched or not .... | .................... | .................... |
| Surface of pebbles .. | .................... | .................... |
| Assorted or not .... | .................... | .................... |
| Kind of stone predominating .... | .................... | .................... |
| Cementation ....... | .................... | .................... |
| Depositing agent .... | .................... | .................... |
| Use of material ..... | .................... | .................... |

Contrast material seen today with that in the quarry as to composition, structure, and age..............................

..................................................

..................................................

Underline the rocks seen today among the following:

Pleistocene

Recent soil

Recent marl

Recent swamp deposits

Glacial stratified drift
Glacial till or bowlder clay
Unconformity

Ordovician
Lower Magnesian limestone

Cambrian.
Madison sandstone.
Mendota limestone
Potsdam sandstone.

Trace the day's route on your map (Fig. 4.).

**Report** Summarize the phenomena observed today in a concise written report. Combine answers to related questions where possible. Be sure and make plain the differences in conditions that would produce deposits such as those at the gravel pit and at the cut near Vilas Park.

Excursion 6

# FAIR OAKS AND THE REGION NORTHEAST OF MADISON

## Ground Moraine and Drumlins

**Directions** Meet at Administration Building, taking the first east-bound Fair Oaks car after 8 a. m. or 1:30 p. m. The total expense is 10 cents.

**On the Car.** Determine from your topographic map (Fig. 5) the extent of relief of the route.

| Place | Height, in feet above sea level. | Ascent or descent |
|---|---|---|
| Administration Bldg | .................. | .................. |
| Capitol Square .... | .................. | .................. |
| Northwestern Station | .................. | .................. |
| Yahara River ...... | .................. | .................. |
| Fair Oaks ......... | .................. | .................. |
| End of Car Line .. | .................. | .................. |

What is the name of a widespread glacial drift formation which is neither terminal moraine, outwash plain, nor drumlin?

..............................................................

You have just traversed one. Describe its surface features.

..............................................................

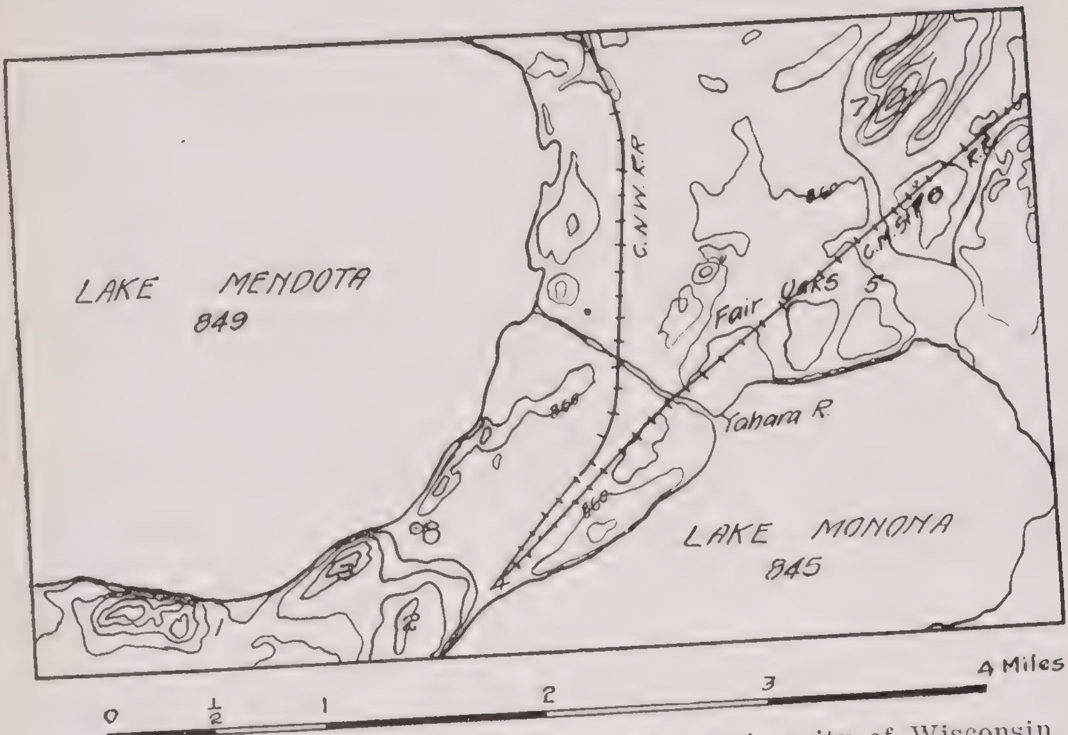



Fig. 5. Map showing the region between the University of Wisconsin and Fair Oaks (after U. S. Geological Survey). (1) Administration Building; (2) Capitol; (3) Langdon hill; (4) Chicago and Northwestern Station; (5) End of street car line; (6) gravel pits near Chicago, Milwaukee, and St. Paul Railway; (7) hill on Sun Prairie road; (8) well at City Pumping Station. Elevations in feet above sea level. Contour interval 20 feet.

What is the origin of the hill upon which the Capitol stands?

University Hall?

Langdon Street east of Frances Street?

Fair Oaks? ..................................................

..................................................

A well at the City Pumping Station (see 8, Fig. 5) reaches the solid rock at an elevation of 754 feet above sea level. How thick is the glacial drift there? ........How thick (assuming an even rock surface) beneath the top of Capitol Hill?........

Taking your distances from Fig. 5, draw a northeast—southwest profile for your report, showing the bedrock topography and drift mantle and present topography along a line from the astronomical observatory (see depth of well, excursion 1) through the city pumping station (see depth of well in this exercise) to Fair Oaks where the glacial drift is 50 feet thick.

**Near Railway Cut** Walking northeastward to the railway cut of the C. M. & St. Paul Railway west of Starkweather's Creek, what post-glacial feature do you cross? ......

What are its materials (see embankments along ditch)?......

..................................................

List the kinds of glacial drift seen in various parts of the pits on either side of the railway. State specific evidence that favors possible formation of some deposits (a) by direct deposition from melting ice, (b) by streams from the glacier, (c) in temporary lakes, and (d) by wind blowing over dry, barren, glacial deposits. Which are stratified? Which unstratified? Which

contain striated bowlders? Prove that these are glacial erratics. Suggest a cause for the folding of some of the clay beds.

Examine bowlders to see if any are weathered. Are all bowlders of the same kind of rock equally weathered?

Suggest an explanation of this.

**Hill Near Sun Prairie Road**

What is the shape of this hill? Its trend? Its dimensions?

What is the material in it, as revealed in the cut on the south-eastern side?

What is the name used for a hill of this origin?

Are its slopes smooth or irregular?

Is there any evidence as to whether they have been modified since the glacial period?

Make a list of the kinds of manufacturing plants seen on the return car ride through Madison. ........................

..........................................................

..........................................................

..........................................................

..........................................................

**The Report** Include in your report a description and concise statement of the origin of the surface topography of a sheet of ground moraine, the nature and thickness of the materials of which it is made, and the oval hills which may diversify it. Tell also how drainage develops upon it and how this drainage may be later modified, using illustrations from this excursion.

EXCURSION 7

## RIDGE SOUTH OF UNIVERSITY BAY

### Topography and Composition of a Recessional Moraine

**Directions** The class will meet at the Administration Building, corner of Park and State Streets, taking the first west-bound Wingra Park car after 8 a. m. or 1:30 p. m. The total expense is ten cents.

**At East End of Ridge North of Railway** How high does the ridge (Fig. 6) stand above the adjacent swamp? ..............

Are there rocks on the surface? Are they water-worn or glacier-worn? ...............................

How do you distinguish a glacer worn pebble from a water-worn pebble? ..............................................

..................................................

..................................................

How could you distinguish this morainic hill from the rock hill to the south at the quarry (excursion 2)? ..................

..................................................

..................................................

..................................................

..................................................

How could you distinguish it from a drumlin? ............

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

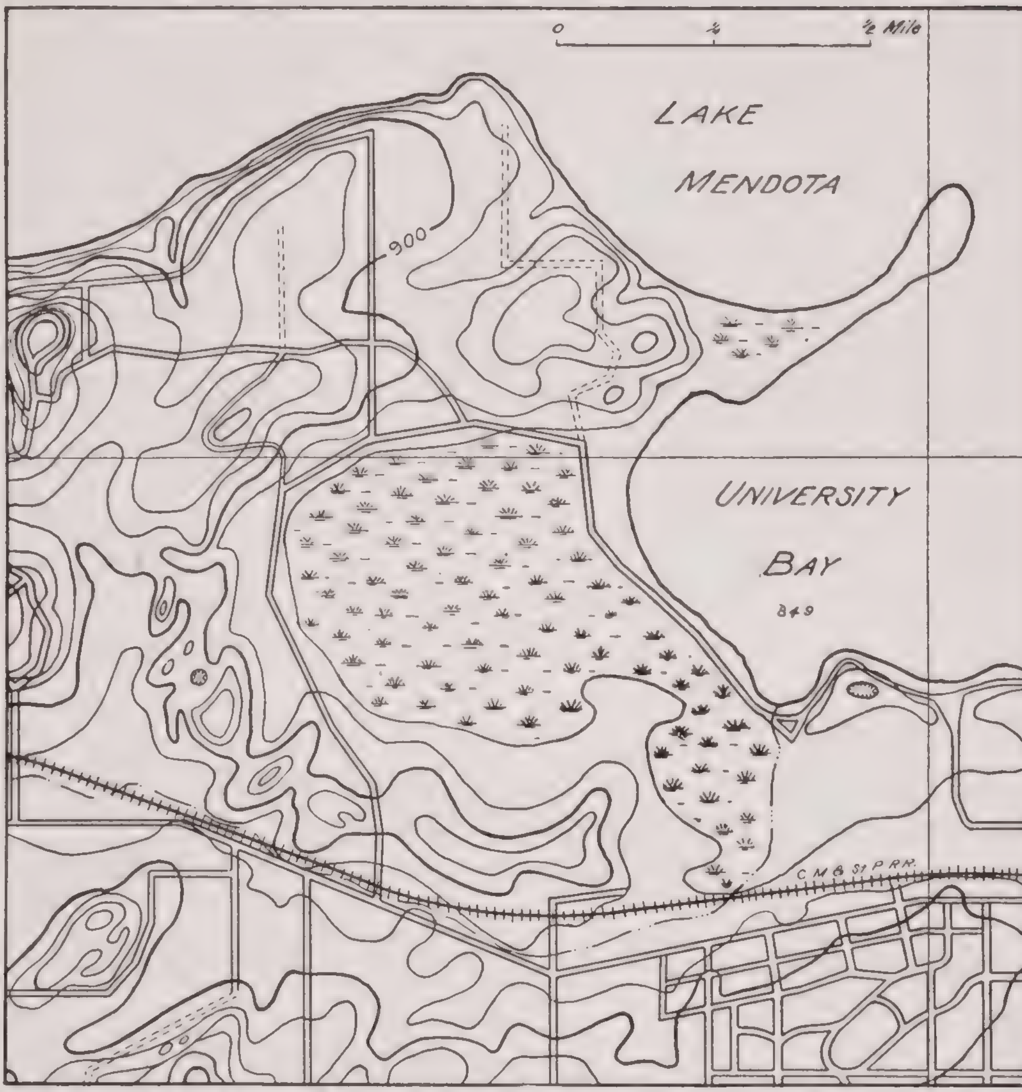



Fig. 6. Map of College Hills moraine at the head of University Bay (after U. S. Geological Survey). Contour interval 20 feet.

**At Gravel Pit East of Road** What are the materials in the bank? . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Are they stratified? ..............................

..............................

..............................

How were they deposited? ..............................

..............................

..............................

Each member of the class will count a hundred stones taken at random. What percentage are (a) limestone? .......... (b) sandstone? ................(c) igneous and metamorphic rocks? ...... ....................

Account for the percentage of each ..............................

..............................

..............................

..............................

..............................

..............................

..............................

**At Pit West of Road** Compare and contrast materials and conditions in this pit with those seen on the east side of the road ..............................

..............................

..............................

..............................

..............................

..............................

................................................................

................................................................

................................................................

................................................................

The material seen thus far has been stratified sand or gravel. Does this mean that the hill is entirely made up of this one kind of material or that man digs gravel pits where water-assorted material is obtainable and does not excavate in other parts of the hill? ........................................................

................................................................

................................................................

Look in the fields next crossed for evidence bearing on this. Describe it. ....................................................

................................................................

................................................................

**Top of High Hill** How high are you above the lake? ............

Above the valley to the south? ................

Above the saddle just crossed? ..........................

What is the trend of the ridge just followed? ..............

................................................................

Are the knobs and saddles due to irregular deposition or to stream work during glacial time? ..........................

................................................................

How much has stream work modified the slopes of the ridge in post-glacial time? ..........................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Excursion 2 showed you the location of the rock outcrops in the City quarry hill to the south. A well in the valley south of the hill you are on goes through 253 feet of glacial material before reaching solid rock. On the profile below (Fig. 7), con-

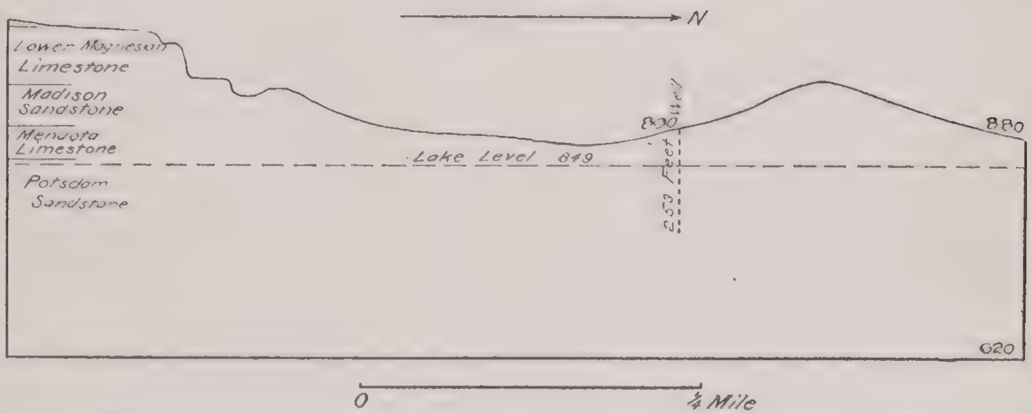



Fig. 7. Cross section from City stone quarry to University Bay (College Hills) moraine. Vertical scale three times the horizontal.

tinue the well to the depth indicated; draw a line showing the probable bed rock surface; and complete the profile by indicating the formations named below by means of the symbols on inside of the front cover.

Quaternary
- Pleistocene till and gravel.

Ordovician
- Lower Magnesian limestone.

Cambrian
- Madison sandstone.
- Mendota limestone.
- Potsdam sandstone.

Has the relief here been increased or decreased by glaciation?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How much for the quarry hill? ..........................

How much for the hill upon which you are standing? .......

..........................................................

..........................................................

..........................................................

**Depressions in Woods to the North** How are the depressions represented on the map (Fig. 6)? ..........................

..........................................

How deep is the large one? ..........................

Why are not others shown on the map? ..................

..........................................................

..........................................................

How much do they vary in depth and size? ...............

..........................................................

..........................................................

..........................................................

These depressions were formed by slumping, which followed the melting of buried ice, and are called kettles. How do they differ in origin from limestone sink holes?..................

..........................................................

..........................................................

From pits among sand dunes? ..........................

..........................................................

..........................................................

..........................................................

The ridge you have been following is a recessional moraine. Make a map of the glacial lobe (University Bay lobe) around the end of which the ridge was formed, assuming that the deposits on University Hill and Picnic Point were made at the same time (Scale 1 inch=1/4 mile). Print the names terminal moraine and lateral moraine appropriately on this map.

How did the water from the melting of the ice of this glacial lobe of University Bay escape? ..............................

..................................................

..................................................

..................................................

....................................................................

Show on your map the marginal lake, if any. What deposits would accumulate in this lake?..........................

....................................................................

....................................................................

....................................................................

What is the geographical significance of the brick works in the valley south of this morainic ridge?........................

....................................................................

....................................................................

Of what uses to man are gravel deposits like those seen today?

....................................................................

....................................................................

....................................................................

Are they more or less useful than till deposits? ...........

....................................................................

....................................................................

....................................................................

**Report** Write a brief summary of the things discussed on this trip, following this outline:—1. Pre-glacial topography; 2. Modification of the pre-glacial topography by glacial deposition; 3. Topographic forms of a recessional moraine; 4. Kinds and uses of materials found in moraine.

## EXCURSION 8

## PICNIC POINT

### Erosional Features of a Shore Line in the Drift

**Directions** The class will meet at the University Boat House at 8 a. m. or 1:30 p. m. The expense is ten or fifteen cents for boat fare.

**At Canoe Portage** In pre-glacial time the local drainage was probably as shown in Fig. 8. Picnic Point was then a

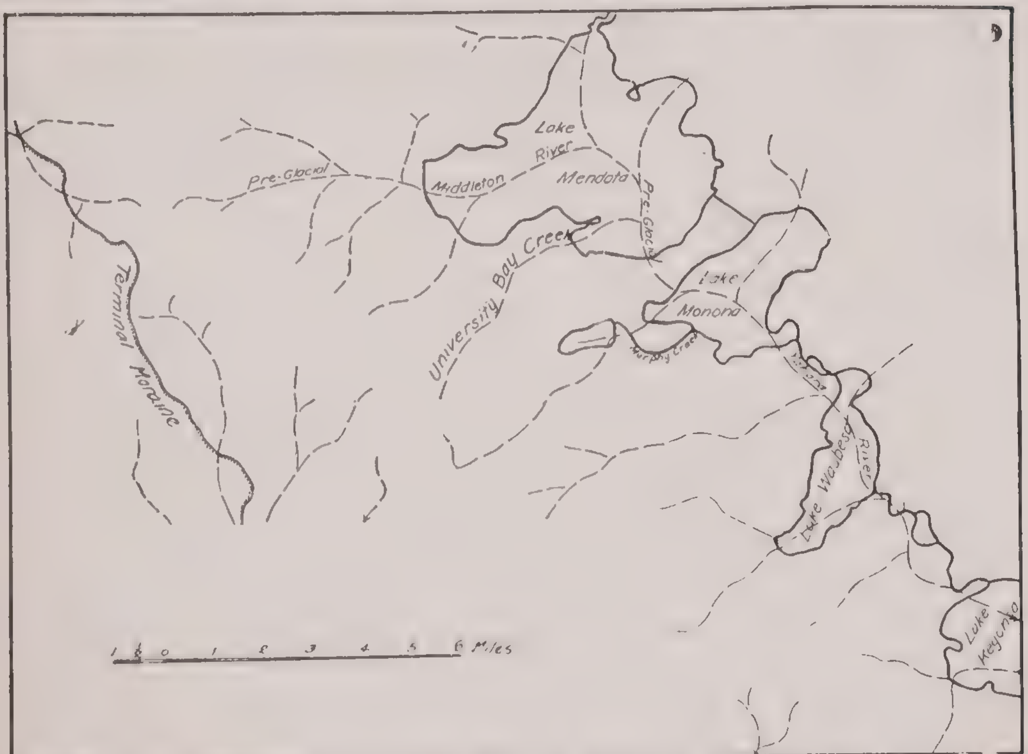



Fig. 8. Map showing preglacial and present drainage of four-lakes region (after F. T. Thwaites).

spur between Middleton River and University Bay Creek. What kind of rock is exposed here (Fig. 16)? ....................

Place in geological column?.......................... What effect will this outcrop have upon future modification of this point?

.................................................................

.................................................................

.................................................................

What is the elevation of the portage above lake level?.........

In Fig. 9 complete the cross section, showing bed rock and drift

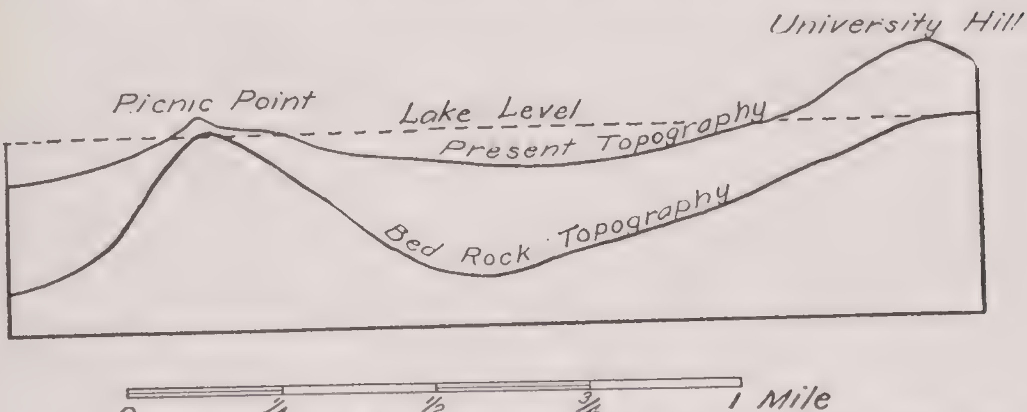



Fig. 9. Cross section of University Bay. Vertical scale five times the horizontal.

topography. How far is this rock surface below lake level, midway between here and Main Hall? ..........feet. Why lower there than here? ..................................

.................................................................

.................................................................

How was this valley formed? By glacial erosion? ...........

By stream erosion?..............................................

What is the character of the material overlying the bedrock?...

.................................................................

What is the origin of this material? ......................

..........................................................

..........................................................

.......................................... How thick is

this deposit above the old valley bottom? .........Has glacial

erosion or glacial deposition done the greater work?...........

Explain. ..........................................

..........................................................

..........................................................

..........................................................

How wide was the University Bay lobe of the continental glacier?

...........mile. At least how thick?...........feet.

**Cliff on Northwest Coast** How was this cliff formed?.....................

..........................................................

...................Is the process still going on?

........................ Evidence. ......................

..........................................................

..........................................................

When did this work begin?..............................

..........................................................

Do wet weather rills modify the cliff?...............Do plants

protect the cliff or aid the process of destruction?............

Explain. ..........................................

..........................................................

..........................................................

**End of Point** What evidence do you see that the end of the point formerly extended farther to the northeast? ......

..................................................

..................................................

List the varieties of rocks seen on shore. ....................

..................................................

..................................................

Where did these bowlders come from? ......................

..................................................

..................................................

Compare the percentage of bowlders found here with percentage at last stop. ......................Explain. .............

..................................................

..................................................

Is this coast then due to constructional or destructional processes? ..........................Why? .........

..................................................

..................................................

Where does the eroded material go?........................

..................................................

..................................................

**Ridges on Southeast Coast** Outline evidence against these ridges having been made by original glacial deposition; ......

..................................................

..............................................................

By wind; ..................................................

..............................................................

By waves. ..................................................

..............................................................

Consider winter ice and the work it performs. Outline the history of these ridges. ..................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

Is there any evidence of recent action? ......................

..............................................................

**Summary** On Fig. 6 make lines showing probable outline of Picnic Point at the end of glacial time. Estimate how much land has been lost to outer Picnic Point. Area at end of glacial period................acres. Area now...............acres

Loss ............... acres.

**Report** Write a brief geological history of the point, follow ing this outline.

1. Pre-glacial deposition; 2. Pre-glacial erosion; 3. Glaciation; 4. Post-glacial erosion.

## Excursion 9

## COVE NORTHWEST OF PICNIC POINT

### Features of Shore Line Transportation and Deposition.

**Directions** The class will meet at the University Boat House at 8 a. m. or 1:30 p. m. The expense is ten or fifteen cents for boat fare.

**Beach on North Side** Define spit, bar, barrier beach....................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

..............................................

Is erosion or deposition dominant here? ......................

What is the character of the material in this beach? ............

..................................................

..................................................

..................................................

If there are waves, study the actual nature of alongshore movement by experiments with small stones or twigs. Describe it and show exact course of object by a drawing. .....................

..................................................

..................................................

..................................................

What are the factors determining the rate of deposition? ......

..................................................

..................................................

..................................................

What determines the size of material that can be carried? ...

..................................................

..................................................

What is the effect of transportation upon the transported material? ..................................................................

..................................................................

..................................................................

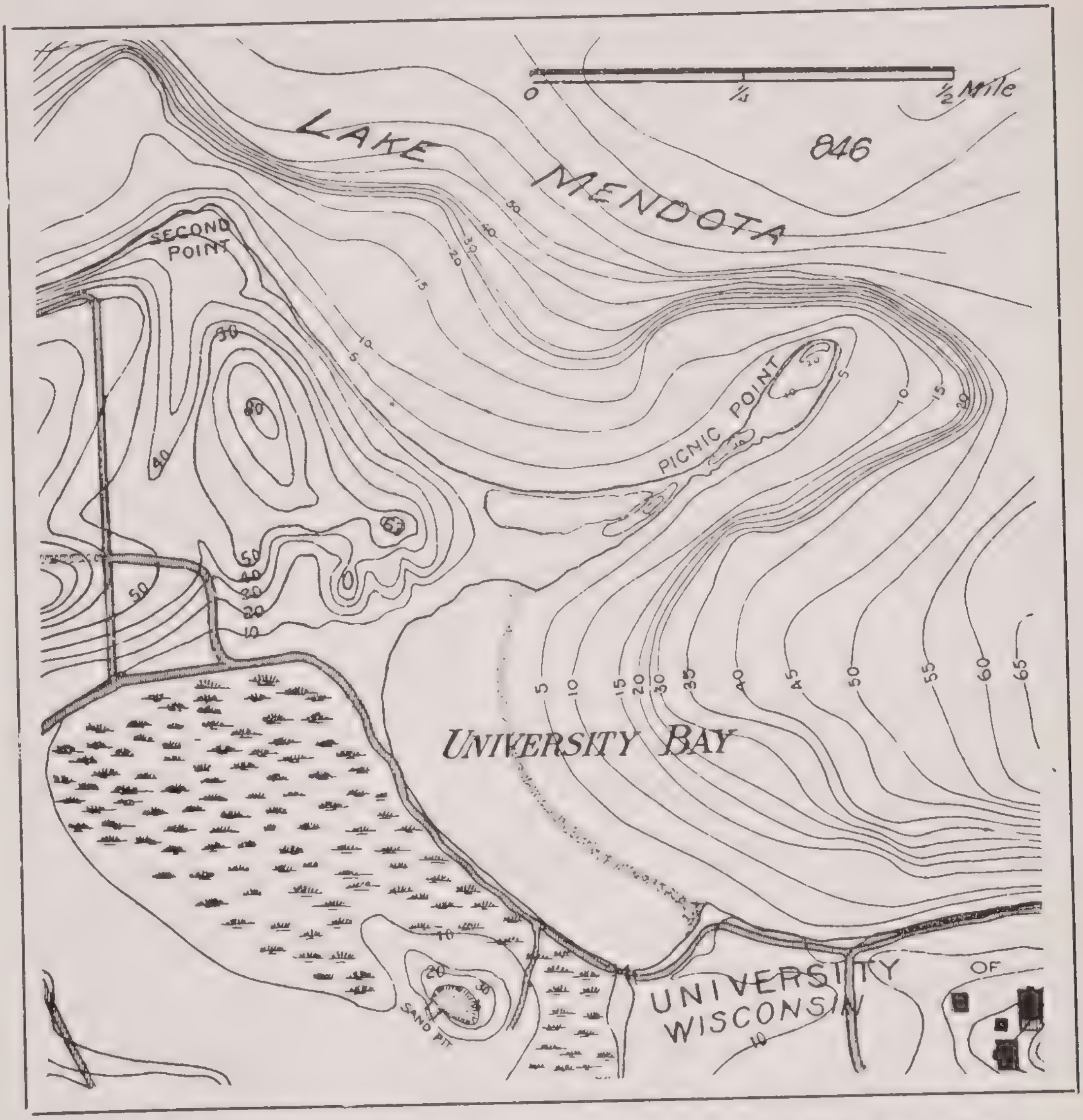



Fig. 10. Map of Picnic Point and University Bay (after L. S. Smith, Wis. Geol. and Nat. Hist. Survey). Contours on the land with 10 foot interval and in the lake with 5 foot interval from lake surface, which is here assumed to be 846 feet above sea level. Submerged sand spit stippled.

Draw a map showing the following features (Fig. 10) :—(a) the present shore line, (b) the old shore line, (c) lagoon.

What are the sources of the sand?..........................

..........................................................

Is this a bar or barrier?...................................

Will there ever be complete adjustment between erosion and deposition on this side of Picnic Point?......................

..........................................................

Is the coast line being made simpler or otherwise?............

Is this the usual rule? ............What effect would the com-

plete destruction of outer Picnic Point have upon this beach?...

.....................................................

.....................................................

What is the meaning of the abandoned cliff behind the lagoon?

.....................................................

How long since the waves were cutting on this cliff? (Note age of trees on the barrier). ..................................

.....................................................

Is there any evidence of an abandoned beach in front of this cliff?

.....................................................

.....................................................

.....................................................

What process dominates in the lagoon?......................

What kinds of deposits are accumulating there?.............

.....................................................

**Point East of Boat House** Is erosion or deposition dominant here?........ ............What are the sources of the material forming this bar?.......................................

.....................................................

What part of it was first built? .........................

.....................................................

Why should it begin exactly here?........................

.....................................................

.....................................................

Where does this submerged bar reach the other shore? . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is its shape convex or concave lakewards? . . . . . . . . . . . . . . . . . .

Why? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Why do reeds grow on parts of it? . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Outline the future history of the bay west of the bar. . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**On the Drive** Outline the history of this drive. . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Where was the old shore line of the bay? . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How has the land west of the road been modified since then? . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Print the following names on Fig. 10; Old shore line, first bar, submerged bar, Indicate by the letter "C" several places where cliff cutting is going on; by the letter "D" places where deposition is in progress.

Estimate the number of acres that University Bay has lost through natural modification. ............acres. What has man done to modify it still further?........................

..........................................................

..........................................................

..........................................................

..........................................................

## Excursion 10

## MAPLE BLUFF

### Wave-Cut Cliff and Other Shore Line Features in Rock.

**Directions** The class will meet at the University Boat House promptly at 8 a. m. or 1:30 p. m. The total expense is fifteen or twenty cents for boat fare.

**On Boat** While the boat is slowly skirting the cliff answer the following. What processes are important in the formation of this cliff? ..............................

..............................

..............................

Which is the most important? ..............................

Why are there irregularities in the cliff face? ..............................

..............................

Why are portions of the cliff overhanging? ..............................

..............................

..............................

How much has the cliff probably receded (see colored map of Lake Mendota)? ..............................

..............................

What becomes of the material that falls or is worn from the cliff?

..............................

..........................................................

..........................................................

Does this material aid or prevent wave erosion? Explain.......

..........................................................

..........................................................

..........................................................

**At East End of Cliff** Upon landing, locate yourself definitely on Fig. 11 and get your map oriented. Explain the formation of the small lagoon just east of the cliff ......

..........................................................

..........................................................

What was the origin of the material forming the bar?.........

..........................................................

..........................................................

If cutting continues on the rock cliff and on the till cliff 200 yards to the east, what will become of this lagoon?.................

..........................................................

Examine the pebbles on the beach. Are they much rounded?...

..........................................................

Why? ..........................................................

Are they of one or two kinds or of many different varieties?...

..........................................................

What is their origin?..........................................

..........................................................

What is the kind of rock forming the cliff at this place? .....

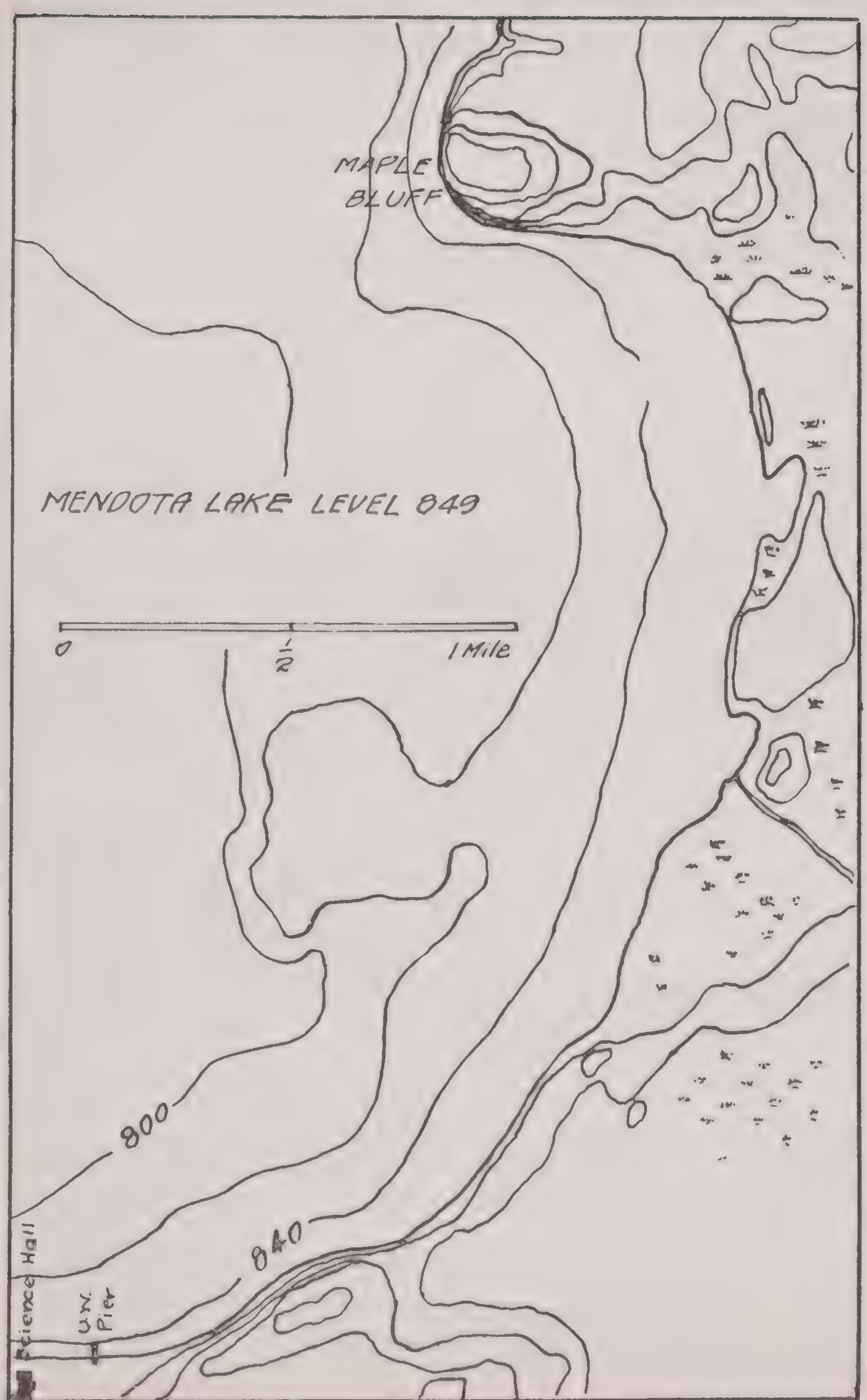



Fig. 11. Map of Maple Bluff and eastern part of Lake Mendota (after U. S. Geol. Survey). Contour interval above and below lake level 20 feet.

..............................................................

If it is of one formation why are there irregularities in the cliff face? ...........................................................

..............................................................

What name is applied to this formation (Fig. 16)? ..........

..............................................................

Why is there a greater thickness of this formation exposed here than at Picnic Point? ..................................

..............................................................

..............................................................

**On Cliff near Round-topped Summer House**

Observe the upper part of the cliff. Is it vertical or slanting? .....................

Is it regular or irregular? ...............

Is jointing prominent? ..................................

What effect has jointing on the outline of the cliff? ..........

..............................................................

..............................................................

..............................................................

Is the rock here apparently a better or poorer cliff-maker than that seen at the east end of the cliff? Reasons for your answer.

..............................................................

..............................................................

Does the lake water reach the top portion of this cliff? .........

...........How then is a vertical cliff formed at this place? ...

..............................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**On West Side of Maple Bluff** Examine the soil at top of cliff. Is it residual or transported? Reasons for your answer?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What class of rock is found at the top of the cliff (igneous, metamorphic, or sedimentary)? . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Kind of rock (sandstone, limestone, or shale)? . . . . . . . . . . . . . .

How determined? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is it generally in thick or thin beds? . . . . . . . . . . . . . . . . . . . . . . . .

Do they vary in thickness? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What peculiarity of color has it? . . . . . . . . . . . . . . . . . . . . . . . . . . .

What name is applied to it (Fig. 16)? . . . . . . . . . . . . . . . . . . . . . . . .

If you have seen this same formation before on any of your excursions, state definitely where. . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Notice the work of animals under the heavier beds of the upper rock. What does this show as to the character of the rock? . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Follow along the slope of the cliff for some distance. Is the rock along the middle portion of the cliff, well or poorly cemented?

Are there bands? If so describe them . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

..............................................................

What causes the differences in color? ........................

..............................................................

..............................................................

Are bands of chert as common here as at the City stone quarry (excursion 2)? .................. Why? ..................

Notice that the cliff on the west side has an upper vertical portion, then a gently-sloping portion, and at the bottom another vertical portion. Account for this. ........................

..............................................................

..............................................................

..............................................................

Draw a profile of the cliff, showing the different formations and using the conventional symbols.

On which portion of the cliff are trees, shrubs, and grass growing? ..............................................

..............................................................

Why? ..........................................................

..............................................................

Notice the recent landslide on the cliff slope. What might have caused it? ..............................................

..............................................................

..............................................................

What effect has the vegetation on these slides? ...............

..............................................................

What probable relation has the present cliff to the original shore line of the lake (use diagrams as well as verbal description in your answer)?

What possible relation has the cliff (a) to the pre-glacial stream in the valley (Fig. 8)? ..............................

..............................................................

..............................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

(b) to glacial erosion? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**Near Boat Landing on West Side** Notice the topography to the north and to the east. Is the rather level portion probably on the Potsdam sandstone or on the Mendota limestone?

. . . . . . . . . . . . . . . . Reasons for your answer? . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is the soil thick or thin here? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Why? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Study the map (Fig. 11) and the topography of the hill. Are there any indications that this hill is a roche moutonnée? . . . . . .

If so, name them. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Draw a northeast-southwest profile of the hill as it appears at present and another as it may have appeared just after the retreat of the ice.

**Report** Write a one-page summary of the excursion, after the following outline:—1. Rock formations and their relations to different parts of the cliff; 2, Origin of cliff; 3. Relation of wave-erosion here to shore transportation and deposition to the east.

## EXCURSION 11

## SOUTH MADISON AND ROCK CUT ON NORTHWESTERN RAILWAY

### Topographic Forms in Rock and Drift

**Directions** The class will meet at the Administration Building, corner of Park and State Streets, taking the first west-bound South Madison car after 8 a. m. or 1:30 p. m. The total expense is ten cents for car fare.

**At South Madison Railway Cut** How high is this ridge above sea level (Fig. 4)? Above Lake Monona? ..........

Of what material is it composed?..........................

..........................................................

Which way does it trend? ..................................

Do you think this ridge is a continuation of the sand hill visited on excursion 4? ........................................

Is the ridge higher or lower than the sand hill?..............

What name is used for such a ridge? .......................

**At Railway Culvert Across Murphy Creek** Draw a rough profile showing the topography from Lake Monona to Murphy Creek. Show on it the nature of the material making up the ridge. Draw (dotted line) on your profile an outline of the agency which made the hill, assuming that it was 150 feet thick at the ridge where the present cut is found and 300 feet thick at Lake Monona.

Southeast of this point is an oval hill with a flagstaff. How far from this point?.........................To the southwest is a hill of similar origin, though somewhat lower. How much lower?......................These hills were made under the ice and are a form of ground moraine. What name is applied to them?...........................Draw a profile of each

Do the profiles differ? ...............................

Why? ...............................................

...................................................

...................................................

Lakes Wingra and Monona are connected by a canal. If the elevation of the former is 849 feet and the latter 845 feet above sea level, suggest a means by which these levels are maintained.

...................................................

..........................................................

What would happen to Lake Wingra if the arrangement suggested above were removed? ..............................

..........................................................

**Where Railway Crosses Highway** Observe the ridge just west of you. Does it connect with the morainic sand hill seen on excursion 4? ..............................

In what direction does it trend? ..............................

Was this ridge formed before or after that south of the railway station? ..............................

From the trend of this ridge which way would you infer the ice sheet retreated in this part of Wisconsin? ....................

Was the glacier edge straight or irregular? ....................

List the kinds of bowlders along the railway from here to the rock cut. Tell what minerals you can see in each.

| Igneous | Sedimentary | Metamorphic |
|---|---|---|
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |
| .................. | .................. | .................. |

**At North End of Rock Cut** What kind of rock outcrops here? ...........

Evidence? ...................................

What is meant by the abbreviations Cml, Cms, and Olm as used on Fig. 12? ......................................

...............................................

...............................................

...............................................

What name is applied to this rock (see Fig. 12)? .............

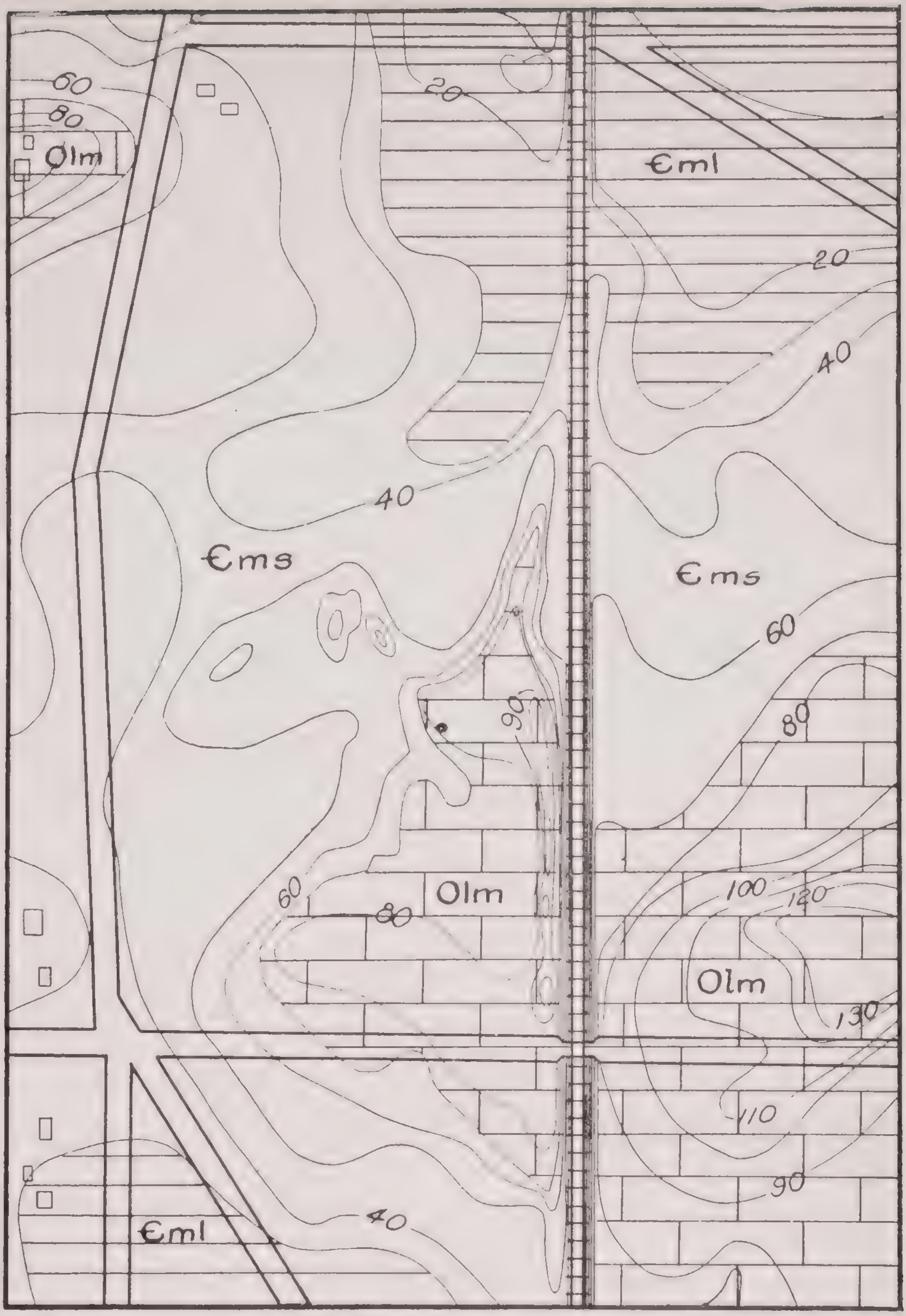



Fig. 12. Geological map of rock cut on Chicago and Northwestern Railway south of South Madison (after W. O. Hotchkiss and others). Contour interval 10 feet. Elevations measured from surface of Lake Monona, 845 feet above sea level. Horizontal ruling (Cml) is Cambrian Mendota limestone; white (Cms) is Cambrian Madison sandstone; brick pattern (Olm) is Ordovician Lower Magnesian limestone.

What colors are seen? ..............................

What causes these colors? ..............................

What is the state of cementation? ..............................

..............................

What is the attitude of the rocks? ..............................

Where on your excursions have you seen rock similar to this?

..............................

**In Cut at Bridge over Railway** How high is the bridge above the track? (note that two, three, and four contours are superimposed in these vertical cliffs and that the bench mark 945 in Fig. 4 is at the bridge and not on the hill top) ..............................

What thickness of rock is exposed here? ..............................

What rock is shown here that was not seen at the north end of the cut (Fig. 12)? ..............................

In what relative position? ..............................

If joints are present describe them. ..............................

..............................

..............................

What evidences of weathering are shown in these rocks? ..............................

..............................

..............................

Is the effect of weathering more prominent in the limestone or the sandstone? ..............................

Why? ..............................

..............................

..............................................................

..............................................................

Is the top layer residual or transported soil? Give reasons for

your answer. ..................................................

..............................................................

..............................................................

..............................................................

Complete the profile of the cut from end to end, showing the position of strata and relative proportions of Madison sandstone, Lower Magnesian limestone, and glacial till (Fig. 13).

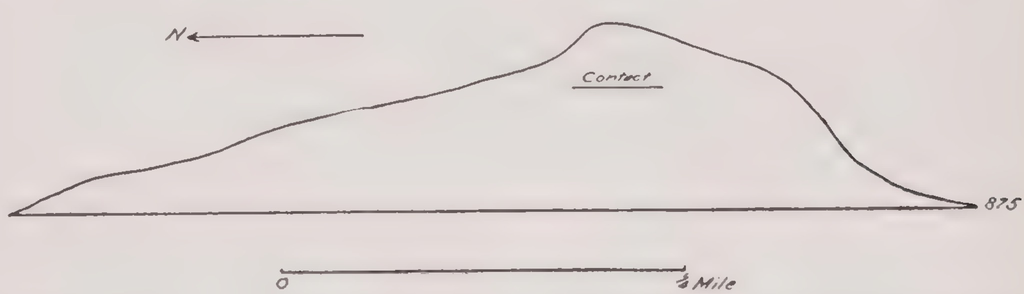



Fig. 13. Cross section of rock hill on Chicago and Northwestern Railway near South Madison. Vertical scale seven times the horizontal.

Use symbols as given on inside of front cover. Insert the names Cambrian, Ordovician, and Pleistocene.

**Top of Rock Hill** What is the local relief of this hill? ..............

If rock at top is exposed up to 970 feet and a well just north on the shore of Lake Monona goes through 115 feet of glacial drift before reaching bed rock, what was the probable

pre-glacial relief of this rock hill? ............................

Was the relief increased or decreased by glaciation? ..........

...........Draw a profile showing the relation of pre-glacial to present topography.

Is the glacial till thinner or thicker on this hill than in the valley to the north? ..............................

Why? ..............................................

..................................................

..................................................

Do you think the till on this hill is as thick as the pre-glacial residual soil was at this place? ........................

Reasons. .........................................

..................................................

..................................................

Oral review of topographic forms studied today.

**Report** Make a list of the topographic forms seen today, telling how each was made and how much and in what way each has been modified since its formation.

EXCURSION 12

## REGION NEAR ESTHER BEACH

### A Drumlin and Other Ground Moraine Topography

**Directions** The class will meet at the boat landing on Lake Monona at foot of Carroll Street (Angleworm Station) at a time to be announced. The total expense is thirty cents; ten cents for car fare and twenty cents for boat fare.

**Esther Beach** How high is the hill at Esther Beach (Fig. 14)?..............Is the hill at Ethelwyn Park a rock hill or a glacial deposit? ....................................

What evidence of each would you look for? ................

.....................................................

.....................................................

.....................................................

.....................................................

Look for the evidence suggested above as you walk across the hill, and summarize your observations in a paragraph. ........

.....................................................

.....................................................

.....................................................

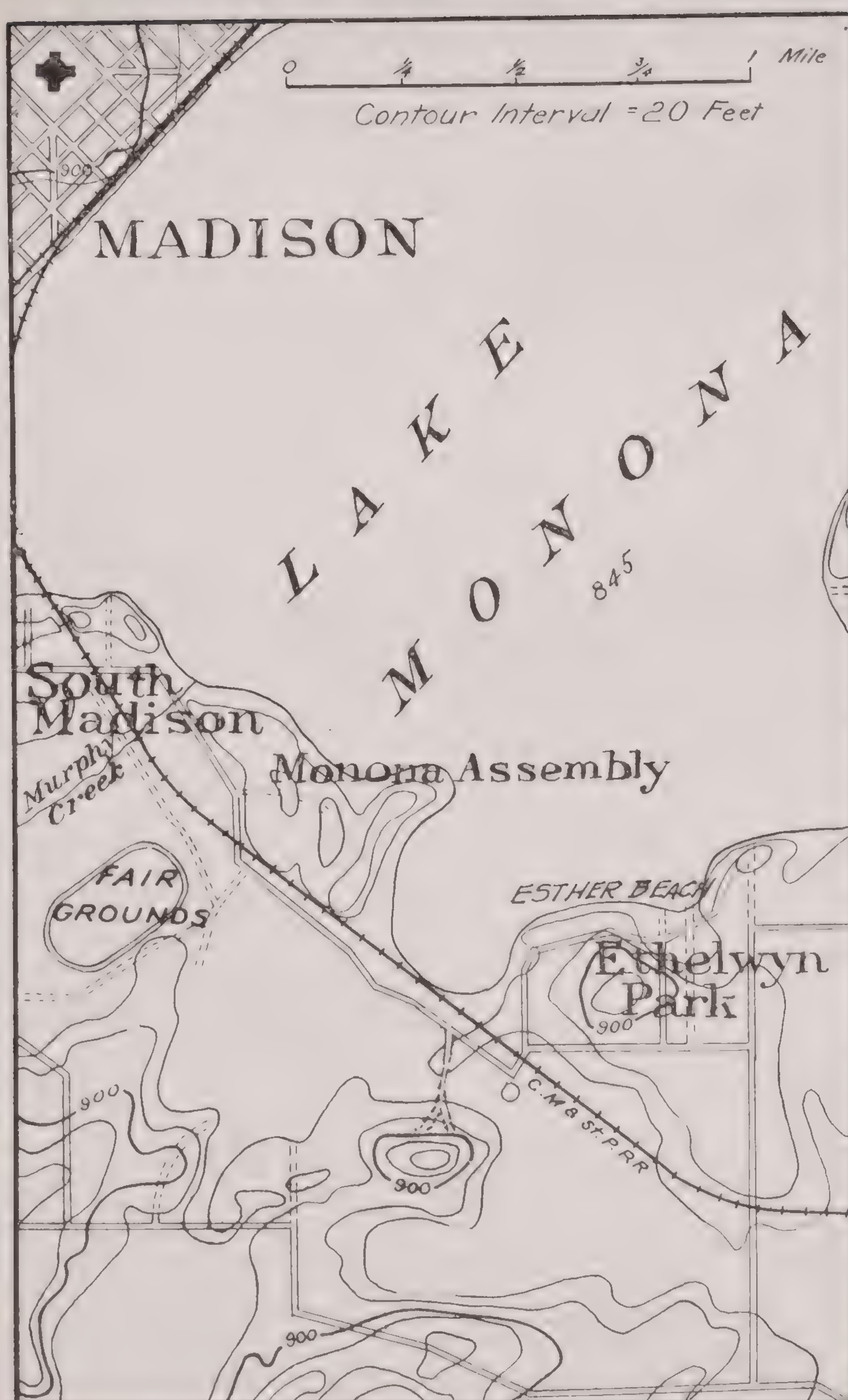



Fig. 14. Map of region near Esther Beach and Round Top (after U. S. Geol. Survey).

**Along Road Leading to Drumlin** Describe the material exposed along the road. . ..................................................

..................................................

What is loess? ..........................................

..................................................

..................................................

What characteristic gives it the appearance of loess? .........

..................................................

..................................................

Is there evidence of erosion on the slopes of the drumlin? ......

..................................................

..................................................

Has post-glacial erosion probably modified this hill to any great extent? ..............................................

..................................................

Does the material exposed on the hillside differ from that seen on the road leading to the hill? .............If so, how?......

..................................................

..................................................

**Top of Drumlin** What is the elevation above sea level? ..........

Above Lake Monona? ..........................

What direction does this hill trend? .......................

Which end is steeper? ....................................

Draw an east-west and a north-south profile of this hill, indicat-

ing the material of which it is made. Use as the base of the profiles the 880 foot contour. (Horizontal scale 1:7920. Vertical scale 1 inch equals 100 feet.

How does this hill differ in composition, elevation and outline from the hill to the west which has the rock cut (excursion 11)?

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

Color or shade all the area in Fig. 14 below 860 feet. Practically all this portion is swamp and former lake area. Was it connected with Lake Wingra? .......... With Lake Monona? .......... With Lake Waubesa? .......... What part has vegetation had in the lake filling? ..............................

..................................................................

What kinds of vegetation are important? ....................

..................................................................

Was the sediment brought in by streams probably very important? .......................... Why? ..............

..................................................................

..................................................................

What has man done to destroy the lakes and swamps? .........

..................................................................

..................................................................

..................................................................

Suggest an origin for the small depressions between this hill and the rock hill to the west. ......................................

..........................................................................

List the rocks found in the pile near the old flagstaff as to class, kind, and composition.

Are they much weathered? ..................................

Which show the result of weathering most?..................

**Report** Trace on Fig. 14, the route taken by the class. Write a one-page summary of the forms and materials found in ground moraine.

EXCURSION 13

## LANGDON STREET AND VICINITY

### Making a Contour Map in the Field

**Directions** The class will meet at the entrance of Science Hall at the regular time, and will go over a route planned by the instructor so that information may be gathered for the making of a contour map. From the following data, draw contours on the accompanying map (Fig. 15) using a 10-foot contour interval. Number each contour. Use judgment in drawing the contours by making a study of the relative steepness of the slopes as well as making use of the elevations given below.

| *Location* | *Elevation feet* | *Location* | *Elevation feet* |
|---|---|---|---|
| President's Residence | 20 | Butler, Johnson and Hamilton | 16 |
| Gymnasium | 8 | Dayton, Hamilton and Webster | 35 |
| Langdon and Lake | 12 | Pinckney and Johnson | 35 |
| Lake and State | 15 | Pinckney and Dayton | 44 |
| Frances and Langdon | 30 | Pinckney, Hamilton and Mifflin | 64 |
| Frances and State | 20 | Wisconsin and Gorham | 45 |
| Gilman and State | 27 | Wisconsin and Johnson | 43 |
| Henry and Langdon | 54 | Wisconsin and Dayton | 48 |
| Henry and Gilman | 42 | Wisconsin and Mifflin | 60 |
| Carroll and Langdon | 70 | Carroll and Gorham | 50 |
| Carroll and Gilman | 57 | Carroll and Johnson | 42 |
| Wisconsin and Langdon | 70 | Carroll and Dayton | 45 |
| Wisconsin and Gilman | 70 | Henry and Gorham | 35 |
| Vilas Residence | 80 | Mifflin, Carroll and State | 50 |
| Pinckney and Gilman | 82 | Dayton and State | 34 |
| Pinckney and Gorham | 44 | Henry, Johnson and State | 25 |
| Butler and Gilman | 32 | Gorham and State | 30 |
| Butler and Gorham | 20 | | |
| Hamilton, Hancock and Gorham | 8 | | |

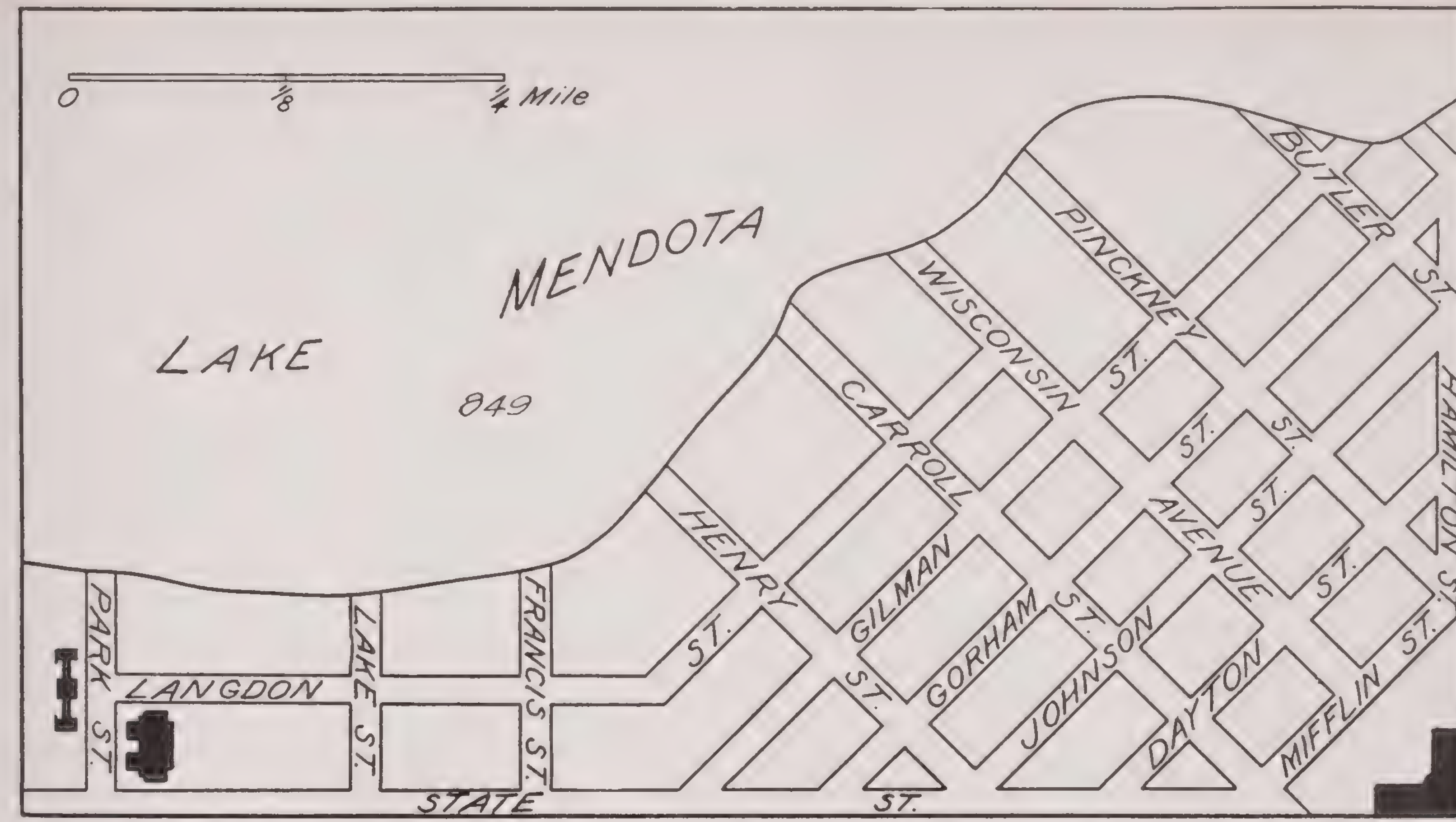



Fig. 15. Plan of streets upon which students are to draw contour map of Langdon Street hill in city of Madison. Elevations in feet above Lake Mendota. Contour interval 10 feet.

## Excursion 14

## INDIVIDUAL EXCURSION WITHOUT INSTRUCTOR

### Collection of Rock Specimens and Description of Materials in University Buildings

**Directions.** 1. Visit either the sand and gravel hill between Lakes Monona and Wingra, the shore of Lake Mendota, excavation for foundation of some building or other easily accessible points, and obtain ten different rock specimens, or collect rock specimens on the various excursions that are taken with the instructor. Two specimens of the same variety of rock, e. g., a red sandstone and a white sandstone, are considered as one kind and, therefore, may not be included as two of the ten required. No minerals may be included as rock specimens, not chert, for example, nor coal. Break open the rock so that each specimen shall have at least one fresh face. Each specimen should be *at least* three inches in diameter (largest dimension.) Number the specimens, place them in a box, and bring them to the laboratory at a time, near the end of the semester, indicated by your laboratory instructor.

**Report.** Write a description of each of the ten specimens, referring to it by number, using an outline similar to the following:

| *Number.* | *Name.* | *Kind.* | *Minerals.* | *Color, hardness, etc.* | *Distinctive characteristics, if any.* |
|---|---|---|---|---|---|
| 1 | Granite... | Igneous.. | Quartz, feldspar, mica. | Light red.... | Coarse crystals. |
| 2 | ........ ... | ............ | ................. | ................. | ..................... |

**Materials in University Buildings** 2. Hand in a list of the buildings named below, and make a table showing for each one (a) the name of rock or other material, (b) class of rock, (c) where obtained; (d) how affected by weathering.

Administration Bldg.
Agricultural Bldg.
Agronomy Bldg.
Gymnasium (foundation)
Music Hall
Chemistry Bldg.
Engineering Bldg.
Law Bldg.
North Hall
Science Hall (basement)

South Hall
State Historical Library.
University Hall
Washburn Observatory
Chadbourne Hall
Lathrop Hall
Home Economics Bldg.
Biology Bldg.
Barnard Hall
State Capitol

Excursion 15

# PART OF THE UNIVERSITY CAMPUS

## The Making of Maps in the Field

This is a voluntary exercise which will be given near the end of the second semester in years when a sufficient number of students request it. It will occupy a whole forenoon (Saturday) and may be substituted for two regular laboratory periods.

The members of the class will work in pairs. Explanation of the use of the compass, military sketching case, plane table, open-sight alidade, aneroid barometer, and hand level. Demonstration of the making of (a) a rough sketch map from compass traverse, (b) a more accurate outline map with military sketching case, (c) a still more precise outline map with plane table and alidade, and (d) the contouring of the last-named map with the aid of the barometer or hand level.

A second period for independent mapping may be elected if desired, but students desiring further instruction in surveying and topographic mapping are referred to courses in the College of Engineering. The second period will be devoted to making a detailed map of a small area of selected physiographic features in the vicinity of Madison.

EXCURSION 16

# UNITED STATES WEATHER BUREAU AND ROOF OF NORTH HALL

## Meteorological Instruments and Methods of Observation

**Directions** The class will meet at the north entrance on the east side of North Hall promptly at 8 a. m. or 1:30 p. m.

**On the Roof** Description of Weather Bureau instruments such as the rain gauge, barometer, maximum and minimum thermometers, wet and dry bulb thermometers, anemometer, and of the instrument shelter. Discussion of types of clouds, percentage of

Write out brief notes on the following page.

cloudy sky, etc.

**Weather Bureau** Explanation of recording apparatus such as thermograph and barograph. Discussion of hygrometer, sling psychrometer, evaporating pan, sunshine recorder, etc. Inspection of various types of meteorological maps and charts and of methods of receiving and recording the data placed on weather maps and used in prediction.

**The Report** Write out brief notes on the features discussed and use these, with those taken while on the roof, in making a brief, concise report to be handed in later.

**Suggestion** It is suggested that students who are interested to do so make a similar excursion to the Washburn Observatory to see the instruments used and methods employed in the study of the heavenly bodies, particularly the stars, planets, and moon and their relations to the earth. Visitors are welcomed at the observatory on the evenings of the first and third Wednesday of each month when weather permits and are allowed to look through the large telescope.

EXCURSION 17

## DOME OF STATE CAPITOL

### General Physiography of the Region about Madison

**Directions** The class will meet on the front steps of University Hall at the regular laboratory hour. Until the dome of the new capitol is completed it will be necessary to use the roof of University Hall for this excursion.

**On the Dome** What great class or classes of rocks have you observed in this region? ........................
........................ If sedimentary, are the layers horizontal or inclined? ..........................

What can you infer from the presence of these rocks as to the former condition of the region? ..........................

..................................................

..................................................

What marked changes have occurred in the region since the time of the formation of the rocks? Explain fully. .........

..................................................

..................................................

..................................................

..................................................

..................................................

..................................................

..................................................

..........................................................

What is the topographic form of the region, that is, is it a plateau, floodplain, mountain valley, etc.? ......................

..........................................................

..........................................................

What is the elevation above sea level of the place on which you are standing, as shown by the map (Fig. 4, p. 47)? ........... ......................... Locate and give the names and elevations of any other conspicuous hills, or summits which are visible ..................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

What rocks form the bottom of the valley at Madison (Fig. 16)? ..................................................

..........................................................

Of what age? .................. What rock formation lies next above it? .................... Where have you seen it on an earlier excursion (if in doubt determine this from Fig. 16)? ..................................................

Tell where you have seen each successive overlying formation shown in Fig. 16, arranging them in order in the following table, beginning at the botton.

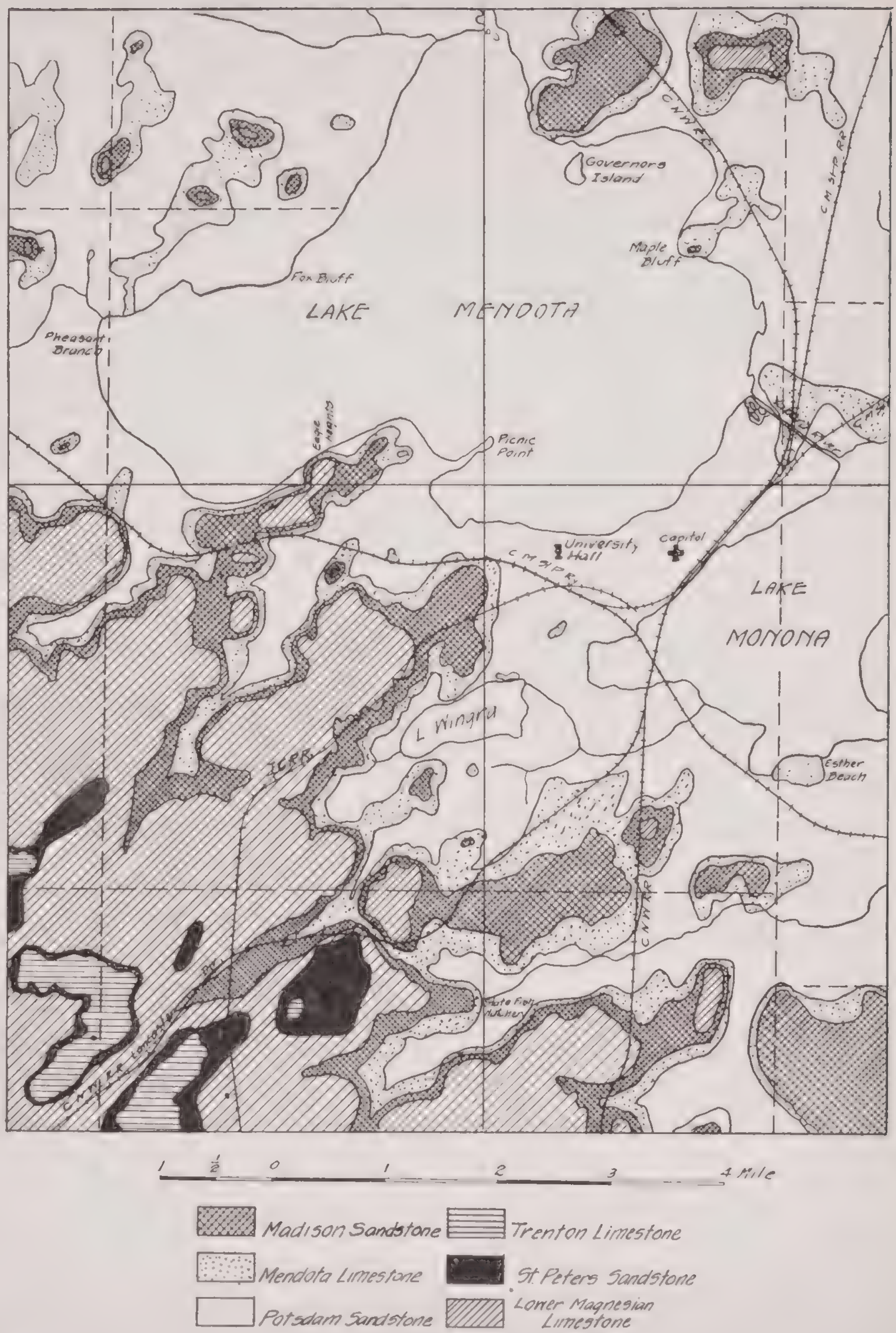



Fig. 16. Geological map of the region near Madison (after F. T. Thwaites).

| Formation | Kind of Rock | Where seen |
|---|---|---|
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| .................... | .................... | .................... |
| Potsdam | Sandstone | Picnic Point |

Make a rough cross-section from Eagle Heights to Maple Bluff, showing topography and rock formations.

Determine from Fig. 17 the general direction of ice movemen. during the glacial invasion. .......... ............

What features of the ground moraine extend parallel to this? ......................... Locate one which you have studied. ..........................................

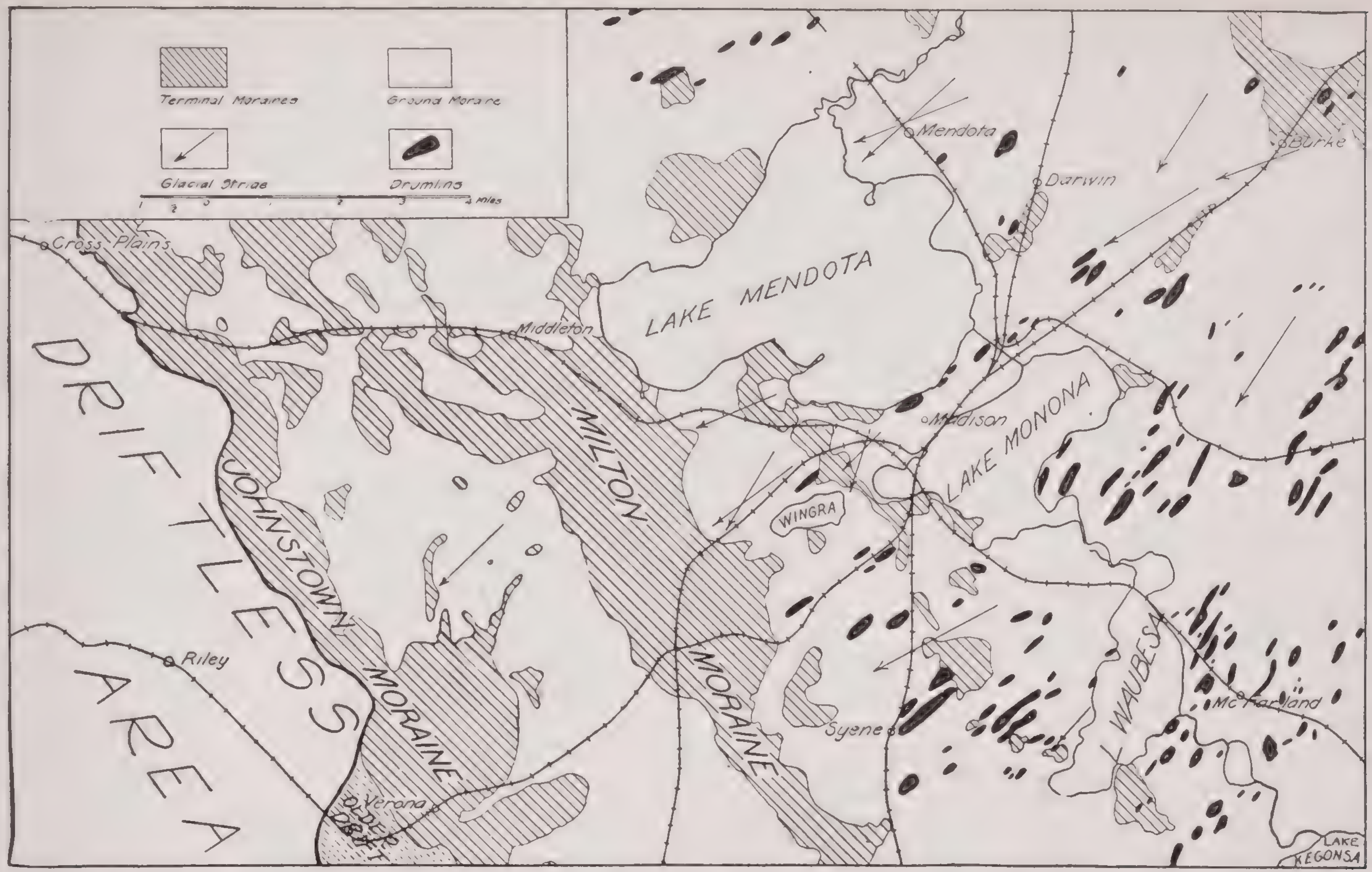



Fig. 17. Map showing glacial geology near Madison (after W. C. Alden and F. T. Thwaites). White indicates ground moraine except in Driftless Area west of Johnstown Moraine.

What features of the glacial drift trend at right angles to the striae? .......................... Where have you studied one? ............................Which is it in order eastward from the Driftless Area? .................... Name the two west of it. .........................................

How many fragmental ones east of it on Fig. 17? ...........

How far is Madison from the Driftless Area (a) to the west? ........... miles; (b) to the southwest? ........... miles.

Tell where you entered the Driftless Area on an excursion of each semester.. .........................................

...............................................................

What can you say of the origin or history of Eagle Heights, University Hill, hill southwest of Esther Beach, and the hill north of Fox Bluff? .........................................

...............................................................

...............................................................

...............................................................

...............................................................

...............................................................

Locate and name the largest stream of the region. ..........

...............................................................

...............................................................

Is it a continuous or an intermittent stream? ...............

What is the source of its water supply? ....................

...............................................................

To what drainage system does it belong? ....................

..........................................................

Has it any tributaries? ....................................

Has it a straight or meandering course? ....................

Why? ......................................................

..........................................................

Does it carry much sediment? .......... Why? ........

..........................................................

..........................................................

Is it cutting down or building up its channel? ..............

..........................................................

What is the topographic age of the stream valley,—young, mature, or old? Reason for your answer. ..................

..........................................................

..........................................................

What caused the lakes? ....................................

..........................................................

..........................................................

Were they ever larger than now? ..........................

..........................................................

..........................................................

How much larger? ..........................................

..........................................................

Make a pair of maps showing (a) the pre-glacial (Fig. 8) and (b) the present drainage near Madison.

What proportion of the Madison Quadrangle is covered with lakes or swamps? ............ Why is there a lock between Lakes Mendota and Monona? ..........................

.................................................................

.................................................................

What was the main physiographic factor which led to the establishment and growth of Madison? ......................

.................................................................

What is the bearing on development of the fact that the Yahara

is navigable or not navigable? ............................

..................................................................

..................................................................

That the region is hilly? ..........................................

..................................................................

..................................................................

Has the location of the roads and railroads been influenced or determined by topography? Explain. ..................

..................................................................

..................................................................

..................................................................

..................................................................

Is the climate of this region humid or arid? .. ............

Has climate affected human occupation? Explain. ........

..................................................................

..................................................................

..................................................................

Is the region an agricultural, mining, or manufacturing district? .................... What factors have determined this? ..........................................................

..................................................................

..................................................................

..................................................................

..................................................................

General oral review of local field work.

**Report** Write a short paragraph stating the origin of the topographic forms near Madison, and a paragraph comparing the physiographic conditions of the region about your home with those near Madison and explaining the influence of the physiography on the settlement, present occupation, and development of the region in which you live.

EXCURSION 18

## BLUE MOUNDS

### Study of Weathering and Erosion in the Driftless Area

**Directions** The class will meet at the Chicago and Northwestern Railway station on Saturday morning at an hour to be announced. The expense is about $1.26 for railway ticket and street car fare. Each student should carry a lunch from Madison. It is usually a little colder at Blue Mounds than at Madison and slightly heavier clothing should be provided. Heavy shoes or boots should be worn. Except by special permission none but members of the class may go on this excursion.

**On the Train** What is the elevation of the Chicago and Northwestern station at Madison above sea level (Fig. 5)? ........

.............. Note the three glacial moraines (Fig. 17), one near South Madison, one near the crossing of the Northwestern and Illinois Central Railways, and the terminal moraine just beyond Verona. Locate these three moraines on Fig. 18. (Part of the following contrasts and descriptions can not be made until we have passed some distance into the Driftless Area). Contrast glacial and driftless topography as to (a) shapes of hills

(moraines, drumlins, rock hills, etc.); ......................

..................................................

..................................................

..................................................

(b) lakes and swamps or none (partly-filled Lake Wingra); ....

..................................................

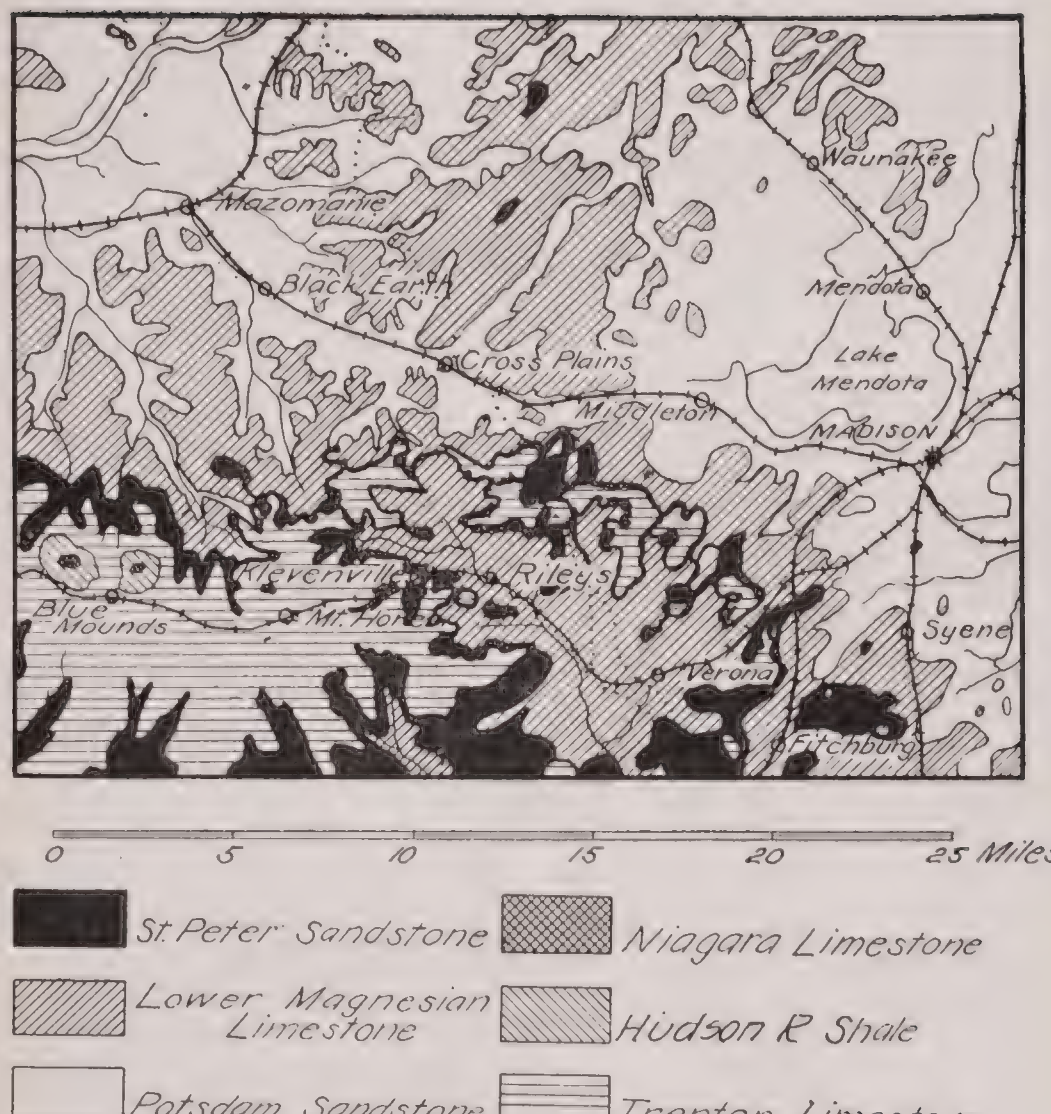



Fig. 18. Geological map of the region between Madison and Blue Mounds (after Wisconsin Geological and Natural History Survey). Terminal moraine shown by dotted line.

..............................................................

..............................................................

(c) ledges present or not; ........................................

..............................................................

..............................................................

(d) erratic bowlders (note railway cuts and stone walls); ....

..............................................................

..............................................................

..............................................................

(e) glacial till or stratified gravel or residual soil. ..........

..............................................................

..............................................................

..............................................................

..............................................................

Contrast the valley forms in the Driftless Area near Riley and Klevenville (Fig. 18) with those near Madison. ............

..............................................................

..............................................................

..............................................................

The elevation at Mt. Horeb is 1240 feet. How much higher is this than Lake Mendota? ..............................

Contrast the valleys descending northward to the Wisconsin River and those sloping southward to the Rock River. ......

..............................................................

..............................................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

May the difference be due to grade? Explain. . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

How may the dip of the rock structure affect these tributary valleys (Fig. 19)? . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is a cuesta? . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is an escarpment? . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Write the words *cuesta* and *escarpment* in their proper places on Fig. 19. Discuss the farms on the north and south sides of

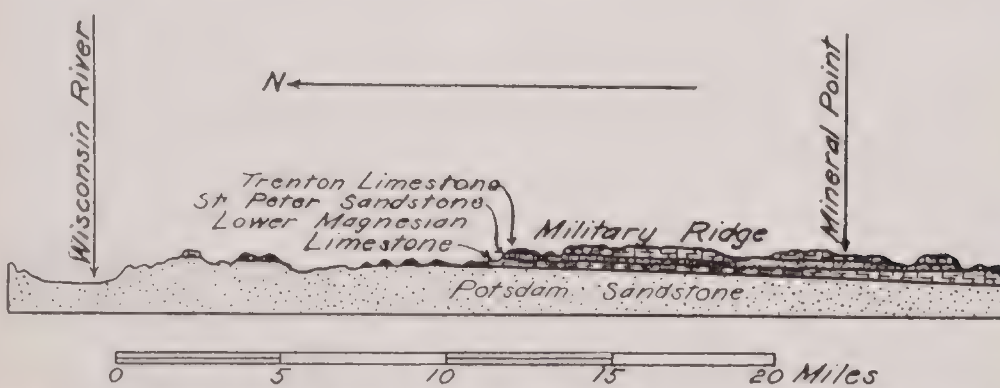



Fig. 19. Cross section of the cuesta of Trenton limestone with its outliers and the valley of the Wisconsin River. Vertical scale ten times the horizontal.

Military Ridge (west of Mt. Horeb) as to (a) number; . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

(b) quality; ......................................

......................................................

(c) size. ..........................................

......................................................

**Near Blue Mounds Station** What is the elevation at Blue Mounds station? (Fig. 20)? ......Is this higher or lower than at Mt. Horeb? ............What is soil? ...............

......................................................

Residual soil? ......................................

......................................................

Transported soil? ....................................

......................................................

Contrast residual soil and transported soil. ................

......................................................

......................................................

......................................................

What is the rock here (Fig. 18)? ........ Are there flints or cherts in it? ....................................

Are there flints or cherts in the residual soil? ..............

......................................................

......................................................

What do you infer as to the resistance of flints and cherts to the agencies which produce soil? .........................

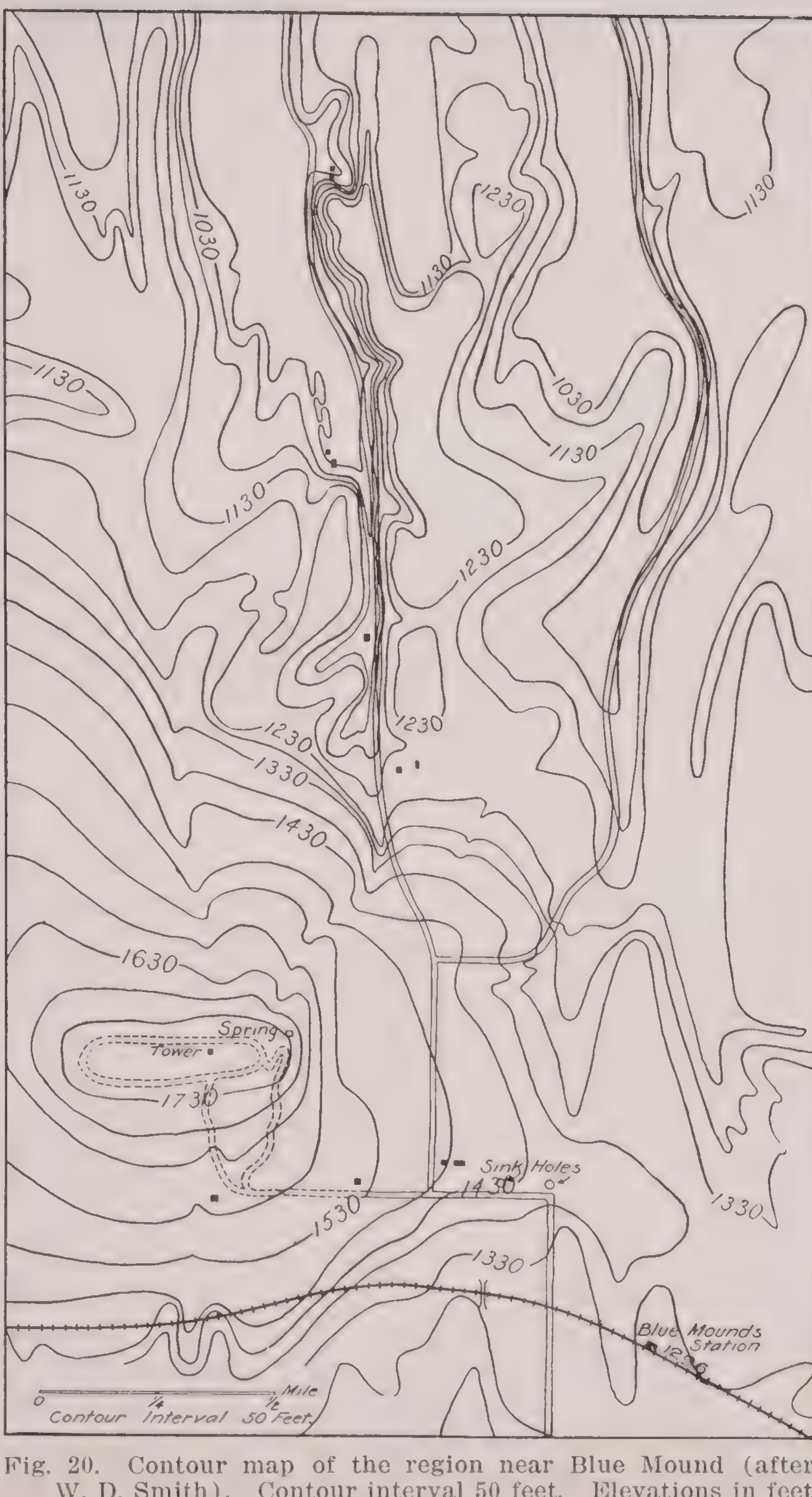



Fig. 20. Contour map of the region near Blue Mound (after W. D. Smith). Contour interval 50 feet. Elevations in feet above sea level.

Review and summary of matters seen on train.

Locate and mark this outcrop on Fig. 20.

**Overhead Bridge** Does the soil here grade down gradually into the rock below or is there a sharp contact between them? . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is it residual or transported soil? . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What name is applied to this rock (Fig. 18)? . . . . . . . . . . . . . . . .

What is a fossil? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Are there fossils in this rock? ..............................

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................

Why are there gray, yellowish, and brown phases of the soil?

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................

What is a probable effect of humic acid? ....................

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................

**At Sink holes** How far are you from the overhead bridge (Fig. 20)? ..........................................

.................................................................

What are sink holes? ............................................

How are they formed?

In what rock formation are they formed (Fig. 18)?

How do they differ from kettle holes and pot holes?

Are the sink holes growing larger?

Why are so many of the trees dying?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Why does this depression not fill with water? . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Under what conditions would it contain water? . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Figure 21 is a map of the cave whose entrance is in the second sink hole on the north side of the road leading to Blue Mound. Does this cave pass under the road? . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . What is its approximate area?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Stalactites and stalagmites are found in this cave. How are they formed? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

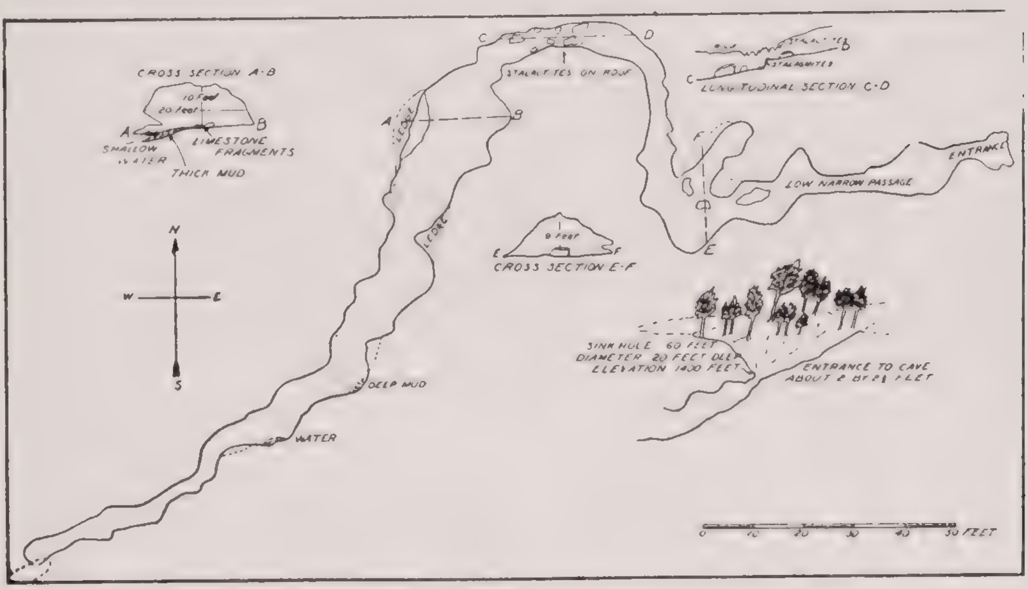



Fig. 21. Map of cave east of Blue Mound (after E. G. Lange).

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What is the source of the material that forms the stalactites and stalagmites? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

What difference did you note in the color of the soil found on the hillside and that in the road near the sink holes? ..........

..............................................................

..............................................................

..............................................................

..............................................................

Account for this difference (Fig. 18). ........................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

**East Side of Mound near Large Cherty Limestone Bowlders**

Note the view to the south. Is it a good farming country? ......................

Describe the size and character of the farms. ..............................

..............................................................

What proportion of the area to the south is under cultivation?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Into what stream do the waters of this region find their way?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Do they flow on the dip or scarp slope of the rock structure?

Explain (Figs. 19 and 22) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

What relation has this area to the ancient belted coastal plain of

Wisconsin? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Discuss the formation of a belted coastal plain. Use diagrams.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

What resistant rock layer is the cuesta-maker here (Fig. 22)?

..................................................................

..................................................................

Are there many bowlders on this slope? ........................

..................................................................

Of what kind? ...................................................

Are they all of the same kind? ...............................

Where did they come from and how did they get here? .......

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

Contrast these bowlders with those found near Madison .......

..................................................................

..................................................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

**Top of West Blue Mound** What is the elevation of the top of Blue Mound (Fig. 20)? ........................

The following formations of the Paleozoic era are found in different parts of the area between Madison and Blue Mounds:

Silurian
- Niagara limestone.

Ordovician
- Hudson River (or Cincinnati or Maquoketa) shale.
- Trenton (Galena and Platteville) limestone.
- St. Peter sandstone.
- Lower Magnesian (or Prairie du Chien) limestone.

Cambrian
- Madison sandstone.
- Mendota limestone.
- Potsdam sandstone.

What are some of the characteristics of each of the above formations? ..........................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

Which one of the formations (Fig. 18) forms the top of Blue Mound; of East Blue Mound?

Why has Blue Mound resisted erosion to such an extent?

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

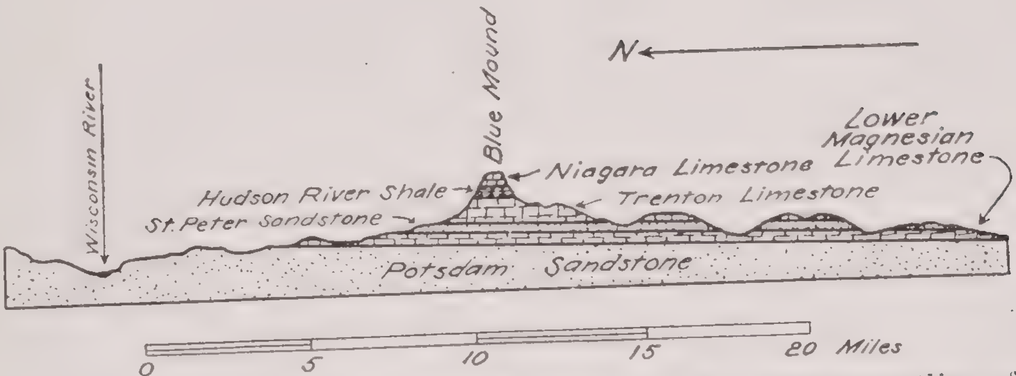



Fig. 22. Cross section of Trenton cuesta with Blue Mound outlier of Niagara limestone. Vertical scale ten times the horizontal.

Blue Mound is an outlier of the Niagara cuesta to the southwest near Dubuque, and Sinsinawa and Platte Mounds are also outliers of this same cuesta. In what direction is each from Blue Mound? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

It is 60 miles southwest and 67 miles east to the main mass of Niagara limestone. What has become of this rock in the intervening distances? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Why is Niagara limestone found to the south and not to the north of Blue Mound? ..............................

..................................................................

..................................................................

..................................................................

..................................................................

Why is it wrong to speak of Blue Mound as a monadnock? ....

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

..................................................................

Does the Niagara limestone cap the Baraboo range?.........

..................................................................

Of what is the Baraboo range composed? ..................

..................................................................

..................................................................

On which side of Blue Mound, north or south, are the valleys deeper? ..........................................

Why? ..........................................

..................................................................

..................................................................

..................................................................

..............................................................

..............................................................

..............................................................

**Luncheon Place** Locate the spring and draw on Fig. 20 the route from Blue Mounds station. Near the spring is the contact between the Niagara limestone and the Hudson River shale. What causes the spring? ..............................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

Is it at the top or the bottom of the shale? ..................

Which do you conclude to be more porous, the limestone or the shale? ..................................................

Why? ..................................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

**Northward Along Creek** Are the light-colored clayey soils along the road produced by the weathering of the shale or the limestone? ..............................

..............................................................

Are the cherts along the road probably from the Niagara or the Trenton limestone? ........................................

Reason for your answer? ........................................

Is the St. Peter sandstone of the same color throughout? ......

Why? ........................................

Note the streams and stream valleys in this part of the drift-less area. How do they differ from those near Madison? ......

Do the tributaries join the main stream with accordant or discordant junctions?

Describe the angle made by this junction.

What is Playfair's law?

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

Do you notice any differences in valley forms in the limestone and the sandstone?........................ Describe and explain. ..............................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

Discuss the influence of limestone and sandstone (as shown in this region) on: Roads; ..............................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

..............................................................................

Soils: ..................................................................

Dwellings;

Crops;

..................................................................

..................................................................

**Southward Up Ridge** What kind of rock is this? ....................

What name is applied to it (Fig. 18)? ..........

................ Where have you seen rock of the same age?

..................................................................

How does the rock in the two places differ? ................

..................................................................

..................................................................

..................................................................

Account for these differences. ..................................

..................................................................

..................................................................

..................................................................

What is a joint? ..................................................

..................................................................

..................................................................

..................................................................

What relation have the joints to the slopes of this sandstone ridge? ..................................................

..................................................................

..................................................................

What relation have the joints to the small cross valleys in this ridge? ..................................................

..................................................................

..........................................................

What effect has vegetation on these joints? ..................

..........................................................

..........................................................

..........................................................

Describe the kinds of vegetation that affect these joints.........

..........................................................

..........................................................

Is weathering active here? State the evidences of it. .......

..........................................................

..........................................................

..........................................................

What other agencies would tend to widen and deepen the joint cracks? ..........................................................

Explain the work of each.

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

Account for the presence of this sandstone ridge..............

.........................................................

.........................................................

.........................................................

.........................................................

.........................................................

.........................................................

.........................................................

.........................................................

.........................................................

.........................................................

Complete the route of your day's excursion on Fig. 20. Transfer this route to Fig. 18. Also transfer the geology of the area shown in Fig. 20 from Fig. 18 showing the different formations by means of coloring or shading.

In case a number of members of the class desire it the afternoon will be devoted to a carriage drive northward from Blue Mound to Black Earth or Mazomanie, with a return by the Chicago, Milwaukee, and St. Paul Railway to Madison. Topography of the St. Peter sandstone, Lower Magnesian limestone, and Potsdam sandstone in a valley from source to mouth.

**Report** Your report should include a brief discussion of all the topics above outlined, with explanations. It should also contrast the processes operative and the topographic forms developed in the Driftless Area, contrasting them with those of the glaciated region near Madison. In conclusion state, as specifically as possible, where on this excursion you saw each of the following:—

(a) Pleistocene Residual soil, glacial till, stratified glacial drift, swamp deposits, marl (organic), stalactites, etc.

(b) The formations shown in Fig. 18 and listed on page 136.

EXCURSION 19

# BARABOO RANGE AND DEVILS LAKE

## Effect of Glaciation on Drainage

**Directions** The class will meet at the Chicago and Northwestern Railway Station on Saturday at an hour to be announced. The expense is $1.42 for railway ticket and street car fares. Lunch may be taken from Madison or obtained at the hotel at Devils Lake. Those desiring it at Devils Lake should inform the instructor in charge of the excursion so that he may notify the hotel proprietor at Devils Lake of the exact number to be expected. Except by special permission none but members of the class may go on this excursion. Wear heavy shoes or boots, as there is considerable walking over rough and stony ground.

**On Train** Most of the route from Madison to Devils Lake lies in a glaciated country. What are some of the visible effects of the glaciation? ......................................

..........................................................

..........................................................

..........................................................

Watch for drumlins on leaving Madison (see Fig. 17). Sketch several in the blank space below.

..........................................................

..........................................................

..........................................................

..........................................................

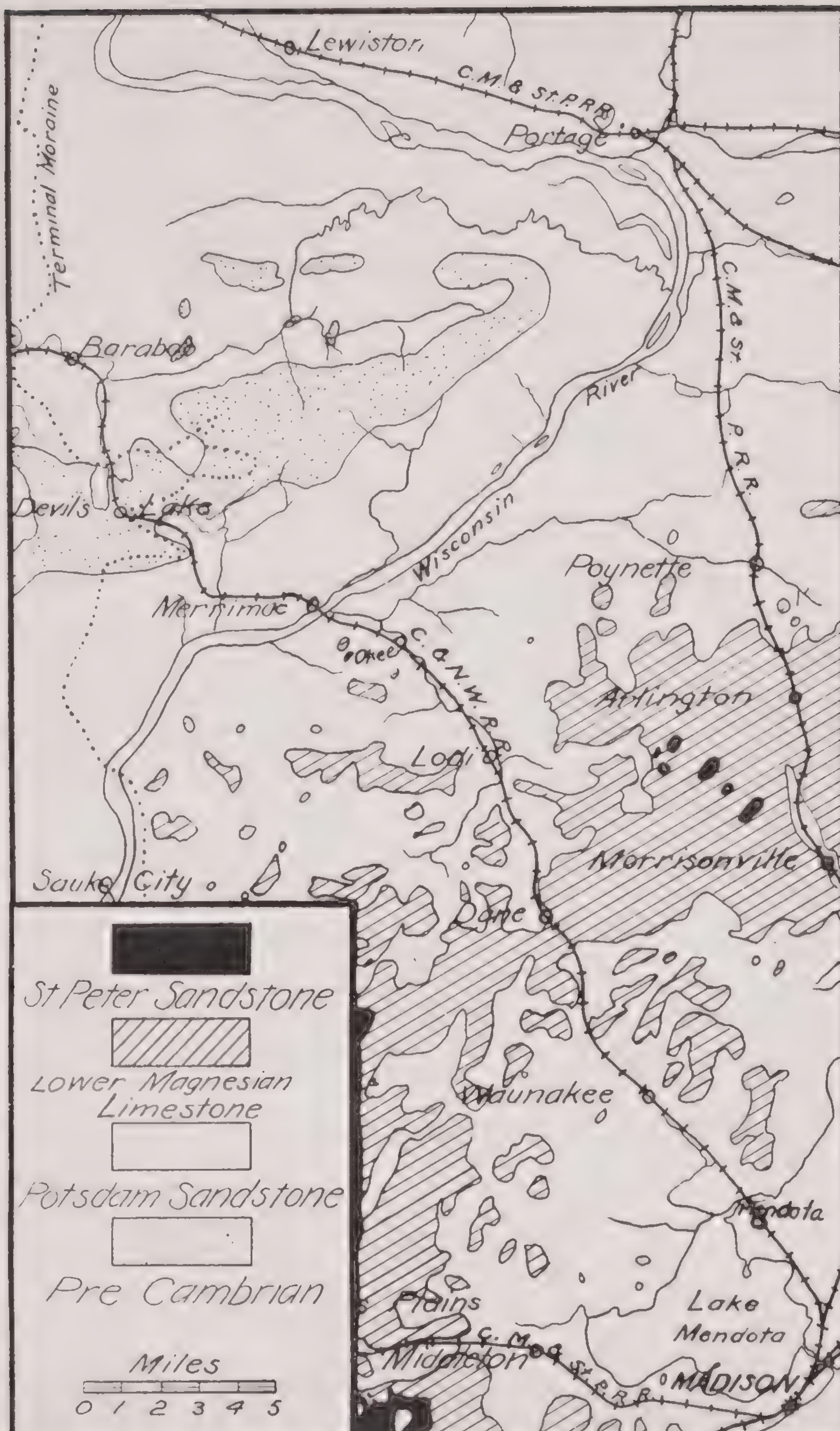



Fig. 23. Geological map of the region between Madison and Devils Lake (after Wisconsin Geological and Natural History Survey). Terminal moraine shown by dotted line.

..............................................................

..............................................................

Describe them in relation to (a) direction of long diameters;....

..............................................................

(b) short diameters; ..........................................

(c) slopes of sides and ends;....................................

..............................................................

..............................................................

(d) heights; ..................................................

Between Madison and the Wisconsin River we ascend the back slope of a cuesta and then descend its escarpment. (Elevation at Madison, 850; Waunakee, 925; Dane, 1080; Lodi, 860; Okee, 810; Wisconsin river, 765 feet). What railway station is nearest the crest (Fig. 23). .................... What station at the base of the escarpment? ................What rock formation is the cuesta-maker (Fig. 23)? ................. How high is the escarpment?..........feet. What is the grade of the back slope in feet per mile? .............What relation do the hills northeast of Lodi bear to the escarpment (Fig. 23)? ..................................................

..............................................................

..............................................................

..............................................................

Study Fig. 24, while going from Dane to Devils Lake, stating exactly where you crossed belts of (a) terminal moraine, (b) ground moraine, (c) outwash, (d) lake clay, (e) sand dunes,

and what topography and drift material you saw in each case.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

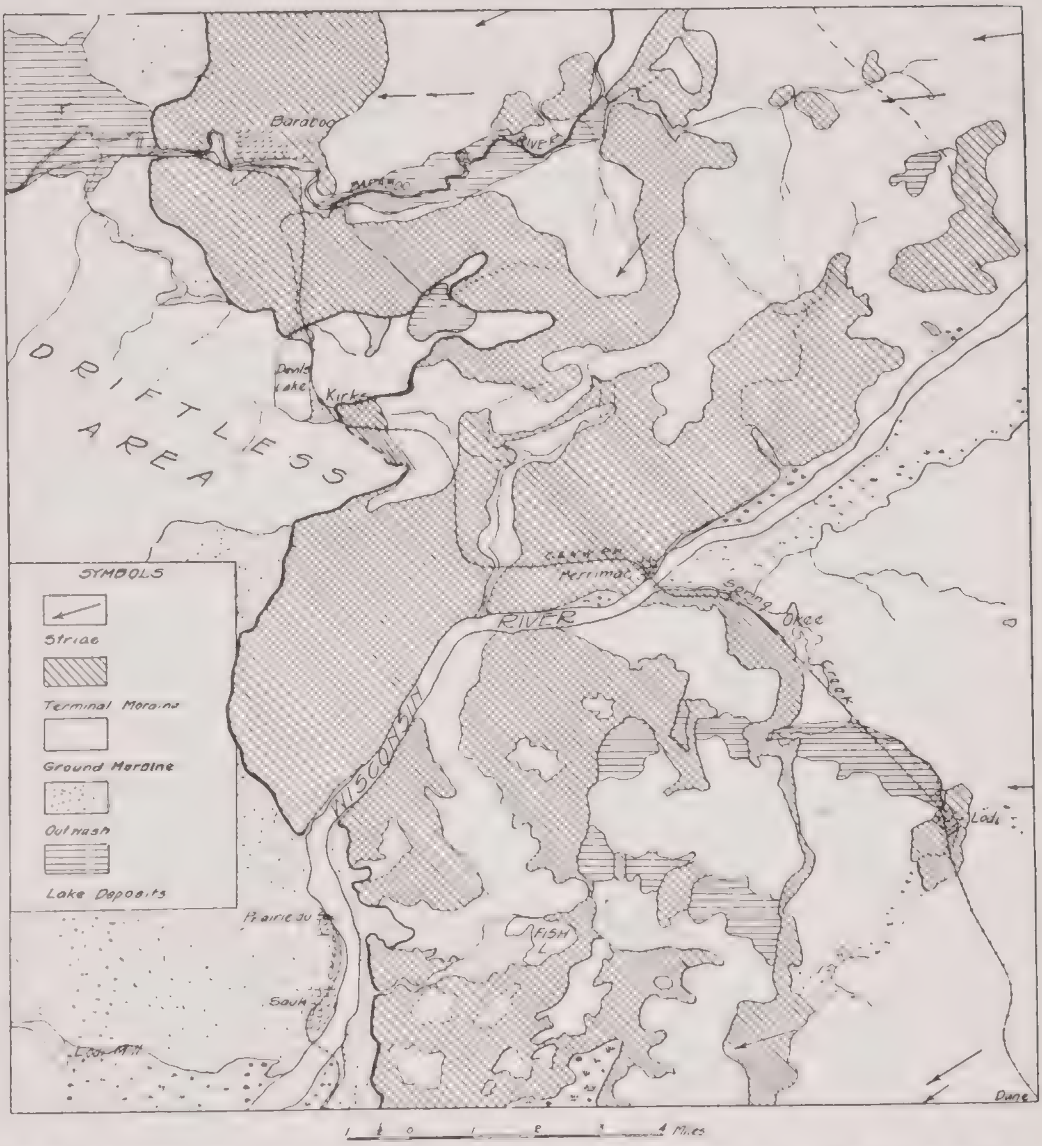



Fig. 24. Glacial map of part of Baraboo Range and the Magnesian limestone cuesta (after W. C. Alden). White indicates ground moraine except in Driftless Area near Devils Lake.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

What was the direction of ice movement (a) west of Dane, (b) east of Lodi, (c) east of Devils Lake? ......................

............................................................

............................................................

What relation does the glacial boundary bear to topography?...

............................................................

............................................................

............................................................

............................................................

Try to discover where we cross the westernmost recessional (terminal) moraine. How do you identify the moraine?..........

...................................................................

...................................................................

...................................................................

On what part of your trip do glacial hills predominate?......

...................................................................

Rock hills? .......................................................

Give reasons for your answers. ..........................

...................................................................

...................................................................

...................................................................

...................................................................

What geological formations (Pleistocene, Cambrian, etc.) are seen between Madison and Devils Lake (Fig. 23)? .........

...................................................................

Make a list of physiographic processes which are especially well illustrated along the route, noting the locality where seen. ...

...................................................................

...................................................................

...................................................................

...................................................................

...................................................................

Is the region between Madison and Devils Lake in a youthful or an advanced stage of erosion? ..........................

Reasons? ........................................................

...................................................................

..........................................................

..........................................................

..........................................................

**At Station** Short review of geological history of the region.

**On Top of East Bluff** How high are you above the lake at this point (Fig. 25)? ..........Suggest an explanation for the Devils Lake gap through the ridge......................

..........................................................

..........................................................

..........................................................

..........................................................

Is this a water gap or a wind gap? ..............Why? ......

..........................................................

What do you conclude from the presence of pot holes on top of the quartzite ridge? ..................................

..........................................................

..........................................................

How high is the Baraboo Range? ..........................

Of what kind of rock is it made (Fig. 23)? ..................

By what rock formation is it surrounded? ..................

Is it a monadnock? ..................How different from Mt.

Monadnock in New Hampshire? . . . . . . . . . . . . . . . . . . . . . . . . . .

Why is it higher than the surrounding country? . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .


Fig. 25. Topographic map of the Devils Lake gap in the Baraboo Range (after U. S. Geological Survey). Contour interval 20 feet. Stippled areas are terminal moraines.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Will this difference in elevation increase or diminish with time?

. . . . . . . . . . . . . . . . . . . . . . . . . Reason? . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

..........................................................

To which of the three great classes of rock does the quartzite belong? ..................................................

How was it changed?..........................................

..........................................................

..........................................................

..........................................................

Where was it deposited?......................................

..........................................................

..........................................................

..........................................................

Would you expect to find fossils in it?.....................

Why? ....................................................

..........................................................

..........................................................

..........................................................

Are any bedding planes visible?.............................

Joint planes?..............................................

Discuss the evidences and extent of weathering seen in the quartzite. ..............................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

**Contact of Quartzite and Potsdam Sandstone.** Mark the site of this contact on Fig. 25. Describe the conglomerate here as to kinds and sizes of the materials..............

..........................................................

..........................................................

..........................................................

..........................................................

Does the Potsdam sandstone rest conformably on the quartzite?

...................... Explain. ......................

..........................................................

..........................................................

What is an unconformity? ..............................

..........................................................

..........................................................

..........................................................

Is the Potsdam everywhere a sandstone?......... What evidence is there that the ridge has been entirely submerged beneath the sea? ....................................

..........................................................

..........................................................

..........................................................

Is the evidence conclusive? ...........................

..........................................................

What has been the subsequent history of the ridge? ..........

..........................................................

..........................................................................

..........................................................................

..........................................................................

When was the gap cut through? ................................

..........................................................................

..........................................................................

Suggest two methods by which the gap may have been made.....

..........................................................................

..........................................................................

..........................................................................

..........................................................................

Was the Baraboo Range glaciated? .............How can you tell whether it was or not?..............................

..........................................................................

..........................................................................

..........................................................................

..........................................................................

..........................................................................

Did the ice probably pass through the gap in which Devils Lake is found? ...............What striking evidence is there in the gap that it did or did not pass through the gap? .........

..........................................................................

..........................................................................

..........................................................................

Account for the peculiar lobate shape of the terminal moraine in

the Baraboo region (Fig. 24.) ..............................

..............................................................

..............................................................

..............................................................

..............................................................

Would Devils Lake have remained driftless if the glacial period had lasted longer? ..............................

Why? ..............................................................

..............................................................

..............................................................

..............................................................

Why is the moraine thick in the valley, thin on top of the ridge, and absent from the steeper slopes? ..................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

Draw three sketch maps showing pre-glacial, glacial, and present drainage conditions in the gap.

**On Railroad Track Along Lake Shore**

What kind of rock is obtained from the quarries along the cliff? .................. Of what use is it? ..................................

..................................................................

..................................................................

..................................................................

What is the attitude of the strata? ..........................

..................................................................

Are any faults visible? ...................................

Explain. .........................................................

..................................................................

..................................................................

Are bedding planes prominent? ..........................

Decide whether the original sediments were deposited in deep or shallow water. ......................................

Reasons? ........................................................

..................................................................

..................................................................

..................................................................

..................................................................

Account for the enormous talus slopes. .....................

..................................................................

..................................................................

..................................................................

..................................................................

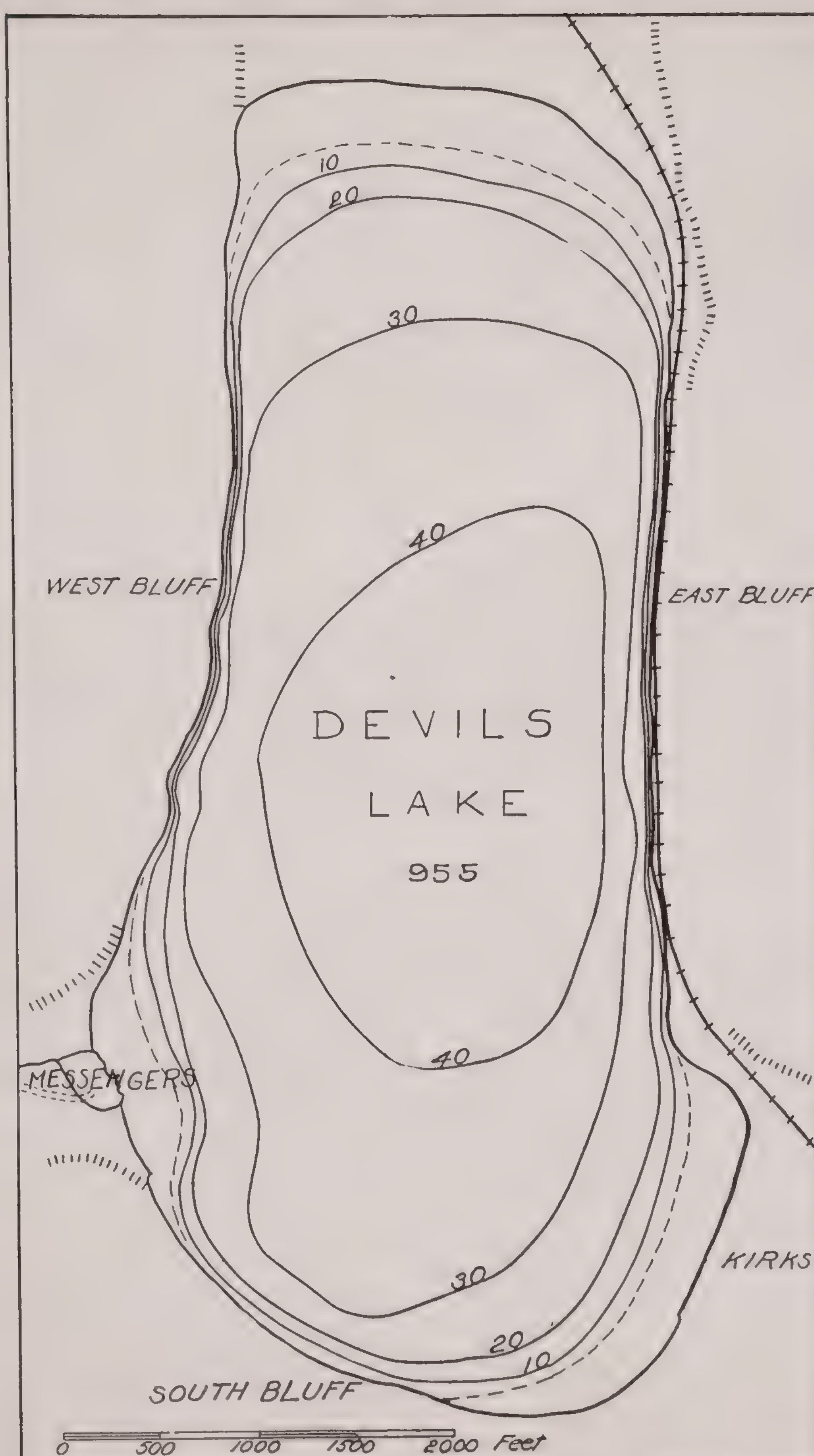



Fig. 26. Hydrographic map of Devils Lake (after F. T. Thwaites). Surface 955 to 959 feet above sea level. Submerged contour interval 10 feet.

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Is there more talus in the glaciated region than in the Driftless Area? . . . . . . . . . . . . . . . . . . . . . . . . . Why? . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Where else in Wisconsin does quartzite outcrop? . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Since it was a sedimentary rock, where did the sediments come from? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

**On Shore Of Devils Lake**

How deep is the lake (Fig. 26)? . . . . . . . . . . . . . . .

Was the lake basin deeper (Fig. 27)? . . . . . . . . . .

How is the lake supplied with water? . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

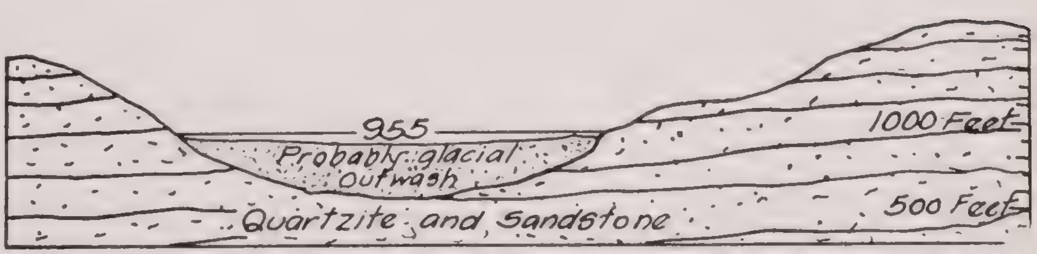



Fig. 27. Cross section of Devils Lake gap. Depth of glacial filling estimated from adjacent wells. Vertical and horizontal scales the same.

Has the lake an outlet? ................How does the water escape from the lake? ..................................

..................................................................

..................................................................

Why is the water not salt? ....................................

..................................................................

..................................................................

Was the lake ever larger than now? ......................

..................................................................

..................................................................

Reasons for answer? ............................................

..................................................................

..................................................................

..................................................................

Are lakes due to the cause which produced Devils Lake common?

..................................................................

..................................................................

Are there ripple marks on the lake bottom? ..................

What caused them? ..............................................

..................................................................

..................................................................

..................................................................

..................................................................

Is the water deep offshore from the hotel or does it grow deep very gradually? ...............................................

..................Is this gentle slope due to wave action or to the original deposition in the outwash plain?................

..........................................................

**On Terminal Moraine Southeast of Devils Lake**

What is the height of the moraine above sea level (Fig. 25)? ..................

Above the lake? .......................

Above the valley to the south? ...........................

Compare the topography and slope of the outwash plain to the north with the terminal moraine. .........................

..........................................................

..........................................................

Of what use are large bowlders in determining which is outwash plain and which is terminal moraine? ................

What kinds of rocks are represented in the bowlders found on the terminal moraine?

..........................................................

..........................................................

..........................................................

..........................................................

Which kind predominates? ..................Why?.......

..........................................................

..........................................................

Are there kettles? ...................................

How formed? ........................................

..........................................................

.....................................................................

.....................................................................

Why is there a more luxuriant growth of vegetation on this moraine than on the nearby ridges and slopes?..................

.....................................................................

.....................................................................

**On the Railroad at Cut in Moraine** Locate this place on Fig. 25. Roughly calculate the depth of the moraine south of the lake. .......................What is the material in the terminal moraine (see Figs. 25 and 27)?...............

.....................................................................

.....................................................................

In the outwash plain? ..........................................

.....................................................................

Why this difference in material? ...........................

.....................................................................

.....................................................................

.....................................................................

Draw a north-south section through this terminal moraine, extending it far enough to show the relation to the outwash plain, the lake, and the valley to the south. The cross-section should include geology as well as topography.

**Report** Give a complete geological and physiographic history of the Baraboo Ridge from the original deposition of the sediments to the present. Explain the topography between Madison and the Wisconsin River. Discuss (a) the relationship of the topography of the Baraboo region to railway routes across Wisconsin; (b) the Wisconsin River as a highway of transportation; and (c) the resources of the Devils Lake region.

Excursion 20

# DALLES OF THE WISCONSIN

## Stream Erosion in the Driftless Area

**Directions** The class will meet at the East Madison Station of the Chicago, Milwaukee, and St. Paul Railway at a time to be announced. The expense is $2.22 for railway and street car fare and fifty or seventy-five cents for boat trip. Lunch should be taken from Madison as there is no opportunity to get meals at the Dalles and no time to purchase anything in Kilbourn before the boat leaves. Except by special permission, none but members of the class may go on this excursion. Wear high shoes or boots as there is some walking over stony and sandy ground.

**On Train** Note and describe the ground-moraine topography. ..............................................

..............................................

..............................................

..............................................

..............................................

Account for the prevalence of swamps. ......................

..............................................

..............................................

..............................................

There is a drumlin west of the track about 2 miles north of the Yahara River and faint recessional moraine topography east of the track at this point (Fig. 17). This is $^3/_4$ of a mile south

of Darwin. Draw profiles of some of the drumlins seen, particularly south of Windsor and at De Forest.

Watch for rock ledges. Are they sandstone or limestone (Fig. 28)? ..................................................

The grade rises gently. The elevation above sea level is 850 feet at Madison, 885 at Darwin, 894 at Windsor, 947 at De Forest, 960 at Morrisonville, and 1040 at Arlington (see Fig. 28). The railway crosses the divide less than a mile north of the Arlington station, descending rapidly to 857 feet at Poynette and 800 at Hartman and Portage. This corresponds to gradually-southward dipping strata of Lower Magnesian limestone and Potsdam sandstone from the divide north of Arlington 20 miles to Madison, and a steep north-facing escarpment between the same divide and the contact of Lower Magnesian limestone and Potsdam sandstone just south of Poynette, which is 4 miles north of the divide. Make a careful profile showing this topog-

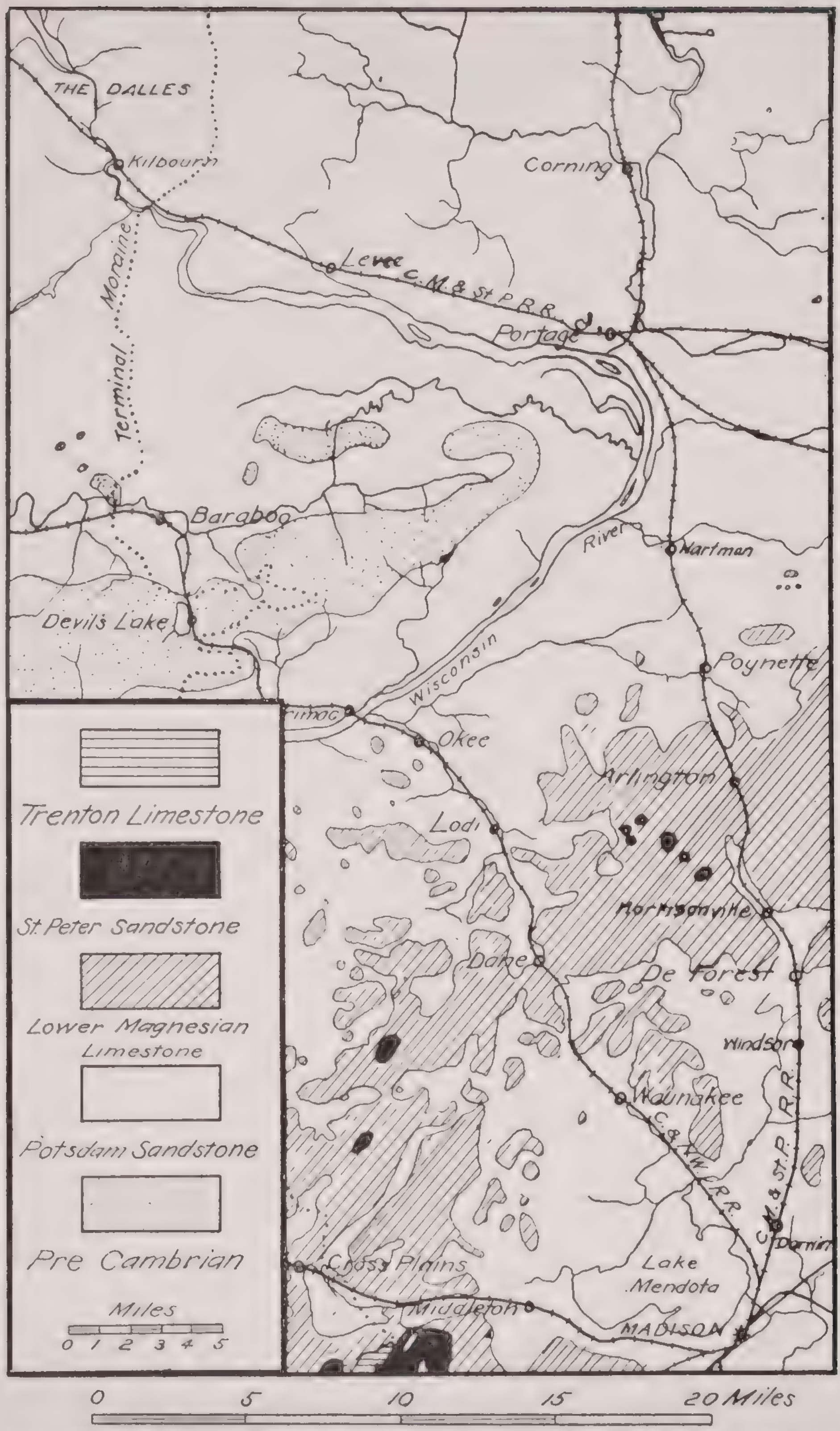



Fig. 28. Geological map of the region between Madison and the Dalles (after Wisconsin Geological and Natural History Survey). Terminal moraine shown by dotted line.

raphy and structure, using the distances and elevations mentioned above.

What difference do you notice in the farms north and south of the divide? ....................................................

....................................................

....................................................

When crossing the swamps near the Wisconsin river south and west of Portage look west and see the end of the Baraboo Range, rising to a height of 500 feet above the river. This range is made of pre-Cambrian quartzite. Why should it stand so high above the river? ....................................................

....................................................

....................................................

East of Portage note the canal connecting the Wisconsin river, which flows into the Mississippi, with the Fox river, which flows into Green Bay, and Lake Michigan. Is this apparently a busy waterway? ........................Do you think it would be if

it were in Germany or in China? ..........................

Will it probably be more utilized in the future? ............

What advantages has it? ..................................

..........................................................

What disadvantages? .....................................

..........................................................

..........................................................

If the Wisconsin River should spill over into this canal during a spring flood would it probably widen and deepen the canal?.... ........Why? ..............................................

..........................................................

What would be the result (a) on the waterpower of the lower Fox River between Lake Winnebago and Green Bay? ..........

..........................................................

(b) on the Wisconsin below Portage? ......................

..........................................................

Could the present drainage system be easily restored? ........

Importance to navigation? ....................To waterpower utilization at Prairie du Sac? ..........................

Why is Portage so much larger than Poynette or Kilbourn? ....

..........................................................

..........................................................

..........................................................

Going westward from Portage, note several north-south-trending recessional moraines between Portage and Kilbourn, especially

the two near Levee. Locate these on Fig. 28. There is a buried valley of the pre-glacial Wisconsin river coming from the north between Portage and Kilbourn. Just after the railway comes close to the north bank of the Wisconsin river again, the track passes through two or three miles of terminal moraine, best seen on the north side of the track. Contrast this with the swampy ground-moraine topography already seen to the east. ..........

..........................................................

..........................................................

Look for striated or transported bowlders. Make notes regarding the width, height of banks, speed of current, and other characteristics of the Wisconsin river for the purpose of contrasting with conditions seen later in the day. ..........................

..........................................................

..........................................................

..........................................................

..........................................................

This terminal moraine marks the edge of the Driftless Area (Fig. 28.) The moraine is shown upon the southeast corner of the map (Fig. 29), crossing the river just east of the name Lower Dalles. In what direction does it trend? .............

How high does it rise above the river? ............Above the plain west of the moraine? ............East of it the country has glaciated conditions. What are they? ..................

..........................................................

..........................................................

West of it there are driftless area conditions. What are they?

..........................................................


Fig. 29. Contour map of the Dalles of the Wisconsin River (after U. S. Geological Survey). Contour interval 20 feet.

............................................................

............................................................

The section of the river from the terminal moraine to the dam near the station at Kilbourn is called the Lower Dalles. Immediately after looking at the glacial till in the last railway cut through the terminal moraine the Lower Dalles should be observed on the south side of the train. Is the river wider or

narrower than to the east? ...............Are the banks till

or rock? ...............High or low? ....................

Are there islands? ............... How formed? ..........

............................................................

............................................................

............................................................

............................................................

............................................................

............................................................

Between this point and the station at Kilbourn the railway cuts show assorted gravel and sand (glacial outwash) and fine wind-blown loess. How can there be glacial materials west of the terminal moraine, beyond which the continental glacier did not

go? ........................................................

............................................................

............................................................

............................................................

**On the Steamer** In what stage of the drainage cycle is the part of the river called the Dalles? ..... ...........Evidence?

............................................................

..........................................................

..........................................................

What kind of rock makes the banks? ................Are the strata vertical, horizontal, or inclined? ......................................... Is the rock jointed? .................. Cross-bedded? ...............................What name is applied to this rock formation (Fig. 28)?..................

Draw a section of the river bank, showing the cross-bedding.

Does jointing influence the form of the banks? ..............

How? ..........................................................

How does jointing influence the side valleys? ................

..........................................................

..........................................................

Of what importance is vegetation? ......................

..........................................................

..........................................................

..........................................................

Explain Steamboat Rock and other islands, the chimney rocks, and the forms in the Navy Yard. ........................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

Are the tributary valleys accordant or hanging? ..............

Why? ..........................................................

..............................................................

Are any of the side valleys larger than that of the Wisconsin River? ..........................................................

Does the width of the main valley vary? ....................

Does the depth apparently vary with the width? ............

Does the current? ..........................................

Account for the sand bars. ..................................

..............................................................

..............................................................

Is erosion or deposition more common? ....................

Evidence? ....................................................

..............................................................

..............................................................

Give the range of width of river in the Dalles (from Kilbourn to Witches Gulch) ..........................................

How wide is the river above the gulch and below the terminal moraine? ....................................................

..........................................................

In what stage of the cycle is the river above and below the Dalles? ..........................................................

How do you tell? ..........................................................

..........................................................

..........................................................

..........................................................

Reasons for differences. ..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

**Witches Gulch and Coldwater Canyon** In what stage of the erosion cycle are these gorges? ..........................................................

How different from the Dalles of the Wisconsin?

..........................................................

..........................................................

..........................................................

Why? ..........................................................

..........................................................

What physiographic change in these gorges since the building of the dam? ..........................................................

..........................................................

..............................................................

What changes would have taken place if the level of the Wisconsin had been lowered instead of being raised? ...............

..............................................................

..............................................................

..............................................................

How deep are these gorges, as shown by the topographic map?

..............................................................

Specific consideration of waterfalls, pot holes, joints, variations of width and trend of gorge, etc., as pointed out by instructor.

Compare and contrast these gorges with Roodes Glen, as you see it from the road and steamer. ............................

..................................................

..................................................

..................................................

**On the Road Between These Gorges** Consider and explain the present topography in relation to geology and drainage history. .......

..................................................

..................................................

..................................................

..................................................

..................................................

..................................................

..................................................

Explain the Elephant's Back ..............................

..............................................................

..............................................................

What is the origin of the soil along the road? ...............

..............................................................

..............................................................

Explain the present position of the Wisconsin River. ..........

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

What relative length of time has it been where it is?.........

..............................................................

What evidence is there of a former lake here? ...............

..............................................................

..............................................................

..............................................................

**The Abandoned Channel West of Artists Glen** Compare the abandoned west-swinging channel with the present gorge between its mouths. ...

...........................................

..............................................................

..............................................................

..............................................................

Why is it not the ox-bow-cut-off of an incised meander? .......

..........................................................

..........................................................

..........................................................

Other possible suggestions of origin? ..........................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

Note the relations of Coldwater Canyon and Artists Glen to this

old channel. ............................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

Make two contour maps, one showing present drainage, the other a stage just before the change took place.

What changes would take place just after such a diversion of drainage? ..........................................

..................................................

..................................................

..................................................

Do Artists Glen and other small tributaries below it enter the main stream with accordant or hanging junctions? ...........

Why? ..................................................

..................................................

..................................................

What is the significance of intermittent streams in some of these gorges? ..........................................

..................................................

..................................................

..................................................

**Stand Rock** What is the origin of Stand Rock? ...........

.......................................................

.......................................................

.......................................................

What significance has Stand Rock as evidence of the non-glaciated condition of the Driftless Area? .......................

.......................................................

.......................................................

.......................................................

Describe an illustration seen nearby of an earlier and a later stage of the erosion form seen at Stand Rock. ...............

.......................................................

.......................................................

.......................................................

.......................................................

.......................................................

What influence have joints had on the formation of caverns?...

.......................................................

.......................................................

What weathering influences are prominent here? ...........

.......................................................

.......................................................

Are there any evidences of wind work? Explain. ...........

.......................................................

..............................................................

..............................................................

Compare the present river with that when your map was made (before building of dam). ...............................

..............................................................

..............................................................

..............................................................

..............................................................

..............................................................

**At Louis Bluff** Describe and explain the features of the Driftless Area and the glaciated region from the top of the bluff.

**Kilbourn** Give reasons for the location of Kilbourn. Discuss the Dalles and the water power as natural resources.

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

..........................................................

**The Report** The report should deal with the topics and explanations outlined above and any other points discussed by the instructors. It will be wise to review on the way home any points not seen well on the way up.

## Excursion 21

## WATERLOO

### Drumlins, Esker, and Bowlder Train

**Directions** The class will meet at the East Madison station of the Chicago, Milwaukee, and St. Paul Railway on Saturday morning at a time to be announced. The expense is 96 cents for railway and street car fare, plus a possible 50 cents for carriage hire. Lunch should be taken from Madison. Each member of the class will be provided with copies of the Madison, Sun Prairie, and Waterloo Quadrangles.

**On Train** Between Madison and Waterloo make notes on the topographic forms seen and the material exposed in railway cuts. Determine the direction of ice movement from Fig. 17 and note its relationship to direction of axes of drumlins. Upon the three topographic maps, outline in pencil as many drumlins as you can see from the train. What evidence of recessional moraine do you see near Burke? Make a general statement about the ground moraine topography.

**Large Drumlin West of Waterloo** Describe the topographic form, outlining the base of the drumlin on your map. Study and describe the material exposed in the railway cut through the drumlin. The report should include a north-south section of the drumlin. Does it contain rock? Are drumlins ever made up of anything but unstratified glacial drift? Are there any other hills in the ground moraine which rise as high as the drumlins?

**Esker Near Waterloo Creek.** Contrast the topographic form and constituent material with that in the large drumlin. While following the crest of the esker, outline its shape on the topographic map.

**Bowlder Train Northeast of Waterloo.** Discuss the quartzite ledges as evidence of the exhumation of a buried monadnock on the pre-Cambrian peneplain. Contrast with Baraboo range (excursion 19). Observe and explain distribution of quartzite bowlders in the glacial drift in various directions from the ledges of Waterloo quartzite. Relation to direction of drumlin axes? Include in your report a map showing what you can of the bowlder train.

EXCURSION 22

# CROSS PLAINS

## Terminal Moraine and Driftless Area

**Directions** The class will meet at the West Madison station of the Chicago, Milwaukee and St. Paul Railway on Saturday morning, at a time to be announced. The expense is 60 cents for railway fare. Luncheon should be taken from Madison. Each member of the class will be provided with copies of the Madison and Cross Plains quadrangles.

**On Train** Study the topographic maps, determining from Fig. 17 where the railway crosses the Milton Moraine. Mark its borders on your map and make notes on the topographic forms there and in the ground moraine. Look for evidence of lake deposits and of outwash gravels at and west of Middleton.

**Field Mapping of Moraine** Leave the train at the railway crossing $3\frac{1}{2}$ miles west of Middleton. Traverse a route specified by the instructor and map the outer or western edge of the Johnstown Moraine northwestward to Cross Plains. Make notes on surface forms and residual and transported soils at various points. Discuss relation of morainic border to bed-rock topography.

EXCURSION 23

# MISSISSIPPI RIVER

## River Erosion and Deposition and General Geography

**Directions.** The class will go (a) by rail from Madison to La Crosse, (b) by river steamboat from La Crosse to Dubuque, and (c) return by train to Madison. By leaving on a Friday noon it will be possible to spend a whole day on the Mississippi and return to Madison early Sunday morning. The total expense will be about $12.50. Copies of the Madison, Baraboo, Denzer, Sparta, Waukon, Elkader, Lancaster, Mineral Point, Galena, and Cross Plains Quadrangles and of Mississippi River charts 125 to 130 (one inch to one mile) and charts 161 to 173 (1:20,000 scale) will be provided.

**Madison to La Crosse** Car window observations of the physiographic features of (a) the areas of Lower Magnesian limestone, Potsdam sandstone, and pre-Cambrian (Huronian) quartzite, in relation to the topography of cuestas, lowlands, and exhumed monadnocks, and (b) of glaciated and driftless topography, soil, drainage, and industries.

**At La Crosse** Study of the east bluff of the Mississippi valley. Relationships of location and industries of La Crosse.

**La Crosse to Dubuque** Discussion of (a) the floodplain and channels of the Mississippi, (b) the bluffs and the trench or gorge within which the river flows, (c) comparisons and contrasts with the gorge of the Rhine in Germany, (d) glacial deposits in the Driftless Area (e) the buried rock floor of the Mississippi, (f) the cause of the abnormal southward narrowing of the river valley from La Crosse to Prairie du Chien, (g) relationships of Potsdam sandstone, Lower Magnesian limestone,

and Trenton-Galena limestone to cross-section of trench, (h) likeness of lower Wisconsin valley near Prairie du Chien and Mississippi valley southward to Dubuque and contrast with other parts of these river valleys, (i) present and former transportation of freight and passengers by water and by rail along the Mississippi valley.

**At Dubuque** Discussion of irregular Niagara escarpment and its outliers near Dubuque. Relationships of location and industries of Dubuque. Contrast with smaller river towns.

**Dubuque to Madison** Ascent of back slope of cuesta of Trenton-Galena limestone, journey along Military Ridge to Mt. Horeb, descent to Magnesian cuesta, and return to Madison. Discussion of Sinsinawa, Platte, and Blue Mounds. Reasons for not regarding these as monadnocks on a peneplain. Geographical relationships (a) of agriculture and dairying to soil and topography, (b) of lead and zinc mining to industries and towns. Contrasts of glaciated and driftless geography.

If a number of members of the class desire to do so, an additional day will be devoted to either (a) a visit to the hydro-electric power plant on the Mississippi River at Keokuk, Iowa, or (b) the lead and zinc mines at Platteville, Wisconsin, or (c) the coal mines of northern Illinois.

EXCURSION 24.

# THE GREAT LAKES.

## Glacial Erosion and Deposition, Wave Work, and General Geography.

**Directions** The class will go (a) by rail from Madison either to Milwaukee or to Sturgeon Bay, (b) by lake steamer to Mackinac Island, Sault Ste. Marie, Marquette, Houghton, and Duluth-Superior, and (c) return by train to Madison. This excursion will occupy three or four days. The members of the class will be provided with copies of certain U. S. Geological Survey maps and Lake Survey Charts M. S. M14, Hd7, Sa1, Sd12, and Sf8.

**Madison to Lake Michigan** Observations of (a) glacial features and (b) topography of areas of Lower Magnesian limestone, Trenton-Galena limestone, and Niagara limestone, with corresponding ridges and lowlands. It may be possible to arrange a stop of a few hours (a) on the abnormally-simple Niagara escarpment, to study its contrasts with the irregular Niagara escarpment near Dubuque (excursion 23), and (b) on the abandoned beaches of the glacial predecessors of Lake Michigan.

**On Lake Michigan** Discussion of the origin of the basin of Lake Michigan and its glacial modification. Submerged hanging valley of Green Bay. At Mackinac Island and several other landing places, brief study will be made, of (a) the beaches of Glacial Lakes Chicago, Algonquin, and Nipissing and (b) the geographical features of the lake ports.

**At Sault Ste. Marie** The Soo rapids. The locks in the canal between Lakes Superior and Huron. Contrasts of volume of transportation at Soo canal and at the Suez, Kiel, and Panama

canals. Contrast of pre-Cambrian peneplain north of the Soo in Canada and the plain of Paleozoic sediments to the southwest in Michigan. Historical geography of the American and Canadian cities at the Soo.

**On Lake Superior** Contrast in origin the basins of Lakes Superior, Michigan, and Huron in pre-Cambrian, pre-glacial, and post-glacial time. Glint lines and lakes. At Marquette the iron ore docks; at Houghton the shipping in connection with the copper mining industry; and at Duluth-Superior the lumber mills, grain elevators, and ore docks will be seen, and the contrast of the water transportation of the Great Lakes and the Atlantic coast will be discussed.

**At Duluth** Study of the Duluth and South Range escarpments and of the peneplain and rift valley. The beaches of Glacial Lake Duluth and the St. Croix outlet. The lake deposits of the plain at Superior. The drowned valley of the St. Louis River. The four sand spits of Duluth and Superior harbors. Wind work and sand dunes. Geographical relationships of the explorations by fur traders, the French *voyageurs*, the Hudson Bay Company, and their successors.

**Return to Madison** The journey from Duluth to Madison will be made by night. If a number of members of the class desire to do so it will be possible to spend an additional day either (a) at the copper mines of Keweenaw Point, or (b) the iron mines of the Mesabi Range, or (c) the pre-Cambrian peneplain of northern Wisconsin and the older drift.